FLIGHT
and
The AIRCRAFT ENGINEER

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The Outlook

Liaison—A Belated Decision

WHILE everyone will welcome wholeheartedly the Air Ministry announcement that arrangements have now been made for a small number of R.A.F. officers with specialised knowledge of active-service operations to be attached to units of the United States Army Air Corps, the view is held fairly generally that such a step is belated, and might well have been taken some time ago. America has had official observers attached to the R.A.F. for some time, but that is not the same thing, although their presence in this country must obviously be of great value. The first duty of the American observers must naturally be that of collecting information which can be applied to the United States air arms, rather than of finding out what must be done to the types of American aircraft lent and leased to us to make them suitable for active service.

It will be argued with sound sense that the British Air Commission in Washington had the duty of looking after that aspect before accepting existing types and approving needed modifications. But it would appear that the members of that commission are mostly Civil Servants with no specialised knowledge of operational requirements, and in any case they have been stationed abroad for such a long time that they cannot possibly be in possession of the latest views on essential fighting equipment. That this has indeed been so seems to be proved by the extensive modifications and changes in equipment which it has been found necessary to make after the aircraft arrived on this side. Great delays have been occasioned thereby. The presence in the United States of two Group Captains and four Wing Commanders of the R.A.F. should help to ensure that the British view is made known to our American friends in good time, so that our ideas can be embodied in the aircraft on the production line, instead of causing delays by stripping machines and incorporating necessary modifications on this side. We are assuming, of course, that these officers will work in the very closest touch with the British Air Commission, so that the benefits of practical war experience can be made immediately available to U.S.A. designers and the production specialists.

The Heavy Bombers

EVERY time an enemy factory which produces munitions of war is badly damaged, every time facilities in the ports which he uses are upset, every time his important communications are cut (even temporarily), the day of victory for the Allies and of liberation for the enslaved countries is brought a little nearer. These blows by themselves are not likely to knock the Germans completely out of action, for history teaches that victory in war almost invariably comes from combined action by all arms, which nowadays means by all our three Services; but striking at production and supply is a very useful step towards final success. It helps to clear the way for the final advance of the mechanised Army with powerful Air Component which will strike the final blow.

In working towards this end the heavy four-engined bomber comes, in the old phrase, as a boon and a blessing. The two-engined bombers have done, and are doing, fine work, and have wrought much destruction, but a Stirling, for example, pays a much better dividend and is much faster. Its average bomb load is staggering,

equal indeed to that of three Wellingtons, or nine Blenheims. Yet its air crew is only greater by one man, and its maintenance squad consists of only eight aircraftmen as against five for a two-engined bomber. Economy in man-power, particularly in trained craftsmen, is a subject which has to be studied with some care in these days, even though the total man-power of the Empire, the United States and the Soviets is far greater than that of the enemy Powers. The wisdom of the Air Ministry in concentrating upon these heavy bombers is almost sure to be justified by the destructive effect which they will be able to exert upon the enemy's war effort. It is the weight of bombs that counts and not necessarily the number of aircraft involved.

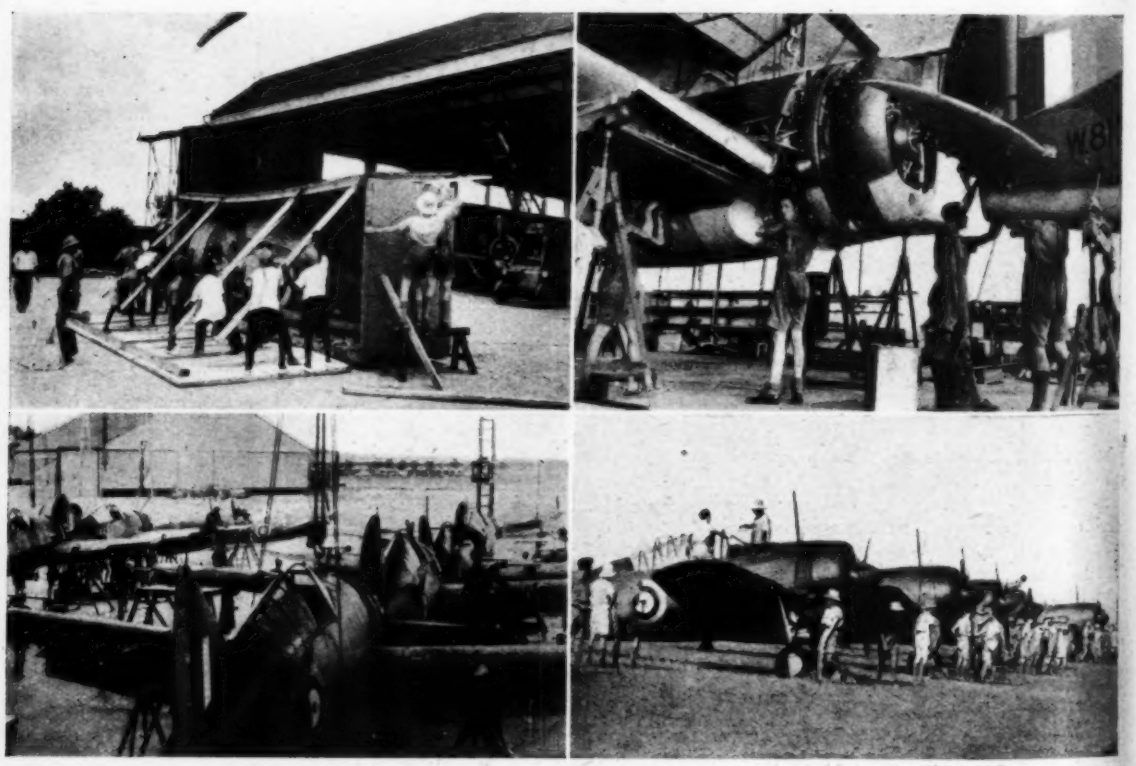
Straight Torque

THE illuminating discussion on torque reaction of contra-rotating propellers shows no signs of abatement. This week we publish a further instalment of letters, and many more have had to be held over for lack of space. There is, however, a noticeable tendency for this correspondence to travel around in circles without getting at the root of the matter. While we have no desire to damp the enthusiasm of our correspondents, the time has come to remind them that there *are* other subjects worthy of thought, and that, in spite of the many opinions to the contrary, they may take it that our original assertion that torque reaction is eliminated by contra rotation if each of the two airscrews absorbs half of the power delivered by the engine, remains unshaken. Small differences may leave a residual torque, but this will be of such insignificant magnitude that its effect on the aircraft may be neglected for practical purposes.

As a corollary we wonder if it has occurred to any of our correspondents that the very first aircraft to fly, that of the Wright Brothers, was fitted with contra-rotating airscrews? They were not co-axial, to be sure, but were mounted outboard aft of the trailing edges of the wings. Drive from the engine was by chains, and one of the chains was crossed. It seems therefore that, unlike some of our modern experts, Wilbur and Orville Wright had no doubts about the elimination of torque reaction by using oppositely rotating airscrews—and that was in 1903!

We would also advise any readers who may still be in doubt to study the article by Mr. W. S. Shackleton in this issue. Without knowing it they may be instructed while they are being entertained. Cloaked by a lot of nonsensical fun there is good sound sense in that article, and we agree with the author not only that aviation is the "coming thing" but that contra-props *do* eliminate torque reaction. There may be a closer connection between the two than is immediately obvious.

BUFFALOES IN MALAYA



With the tension in the Far East becoming greater each day, heavy reinforcements of both men and machines are arriving at Singapore. Aircraft are shipped direct from America and the four photographs above show the uncrating, erecting, housing and flying of Brewster Buffaloes. These single-seat fighters may not pack quite the punch of a Hurricane II or a Spitfire V, but they are loved by pilots and should be equal to anything the Japs put in the air.

War in the Air

Raiding and Counter-raiding: The Joy of Night-fighting: Naples' Bad Night: The Fleet at Tobruk

VICHY'S FRIENDS: A Mitsubishi Karigane and air crews of the Japanese army on an aerodrome near Saigon in French Indo-China.

THE Germans seem to have been goaded by the weight of the R.A.F. raids into showing that they still have a number of bombers left in France, and have shown more activity over this country of late than they had shown for a considerable time past. One night last week their bombers flew over Great Britain at a great height and made for the North-West and North-East of England. Merseyside was admittedly visited, and the Germans themselves claimed that they had bombed Liverpool and Newcastle—but their navigators do not always know exactly where they are over blacked-out Britain. The height at which the raiders flew suggested that the raids were in the nature of training for inexperienced crews. A town in the South-East was raided on the following night. None of these raids was heavy, though some damage was done and some people were killed and wounded. On one of those nights the R.A.F. sent bomber forces over Germany which were seven times as strong as the enemy raids on this country. They bombed several ports in North-West Germany, mainly Bremen, Wilhelmshaven and Emden. At the same time Coastal aircraft bombed a seaplane base and a factory in Northern Denmark.

The Fighter Command continues its spirited daylight sweeps over occupied territory, and the new Hurricanes with their increased fire power play a very effective part in them. The four cannons in some of these machines are proving very effective for attacking ground targets. One particularly good piece of work was an attack on an ammunition train. Our pilots were flying low when they came across it, and when they opened fire the third waggon blew up with a terrific explosion. The whole train was derailed and set on fire. At other places German troops on the ground were machine-gunned, and suffered heavy casualties.

Everyone has heard with delight of the growing success of our night-fighters, but few have any clear idea of what happens. The following is an extract from a recent broadcast given by a Squadron Leader, who has won the D.F.C. and has definitely shot down four enemy bombers over their own aerodromes. He is believed to have damaged many more. The Squadron Leader said:—

"First of all, I should like to tell you not to measure the value of this night-fighter work over German aerodromes only by the number of enemy aircraft known to have been destroyed. This is considerable, but I know positively that our mere presence over the enemy's bases has caused the loss of German bombers without even a shot being fired at them. . . . Night-fighter pilots chosen for this work are generally of a different type from the ordinary fighter pilot. They must like night fighting to begin with, which is not everybody's

UNDER COVER: A Russian Ack-Ack gun under camouflage on the Leningrad front. It appears to be rather similar to the German 88 mm. gun.

WAR IN THE AIR

meat. . . . Personally I love it. . . .

"My own successes stand out clearly in my mind. There was one night over France when I got an He 111 for sure and a Ju 88 as a probable. It was the night of the last big raid on London, and the Huns were streaming back to their bases in swarms. I got a crack at the Ju as, with navigation lights on, it came down to land. The bullets appeared to enter the starboard engine and fuselage of the bomber. My onward rush carried us over the Ju some 10ft. above it, and as we passed my rear gunner poured a longish burst into the port engine. The bomber went into an almost vertical dive. She was only 800ft. up, and it is practically impossible that the pilot could have pulled out of the dive, apart from the fact that both his engines were damaged. But we only claimed the Ju as a probable.

"After this, all the aerodrome lights were turned off. But there were numerous bombers still trying to land. We came down to 1,000ft. again and met an He 111. I opened fire close in. The bullets entered one engine and the fuselage. After a second burst smoke poured from both engines, and it went into a steep, side-slipping turn. As we passed beneath her, the gunner put another burst into the beast.

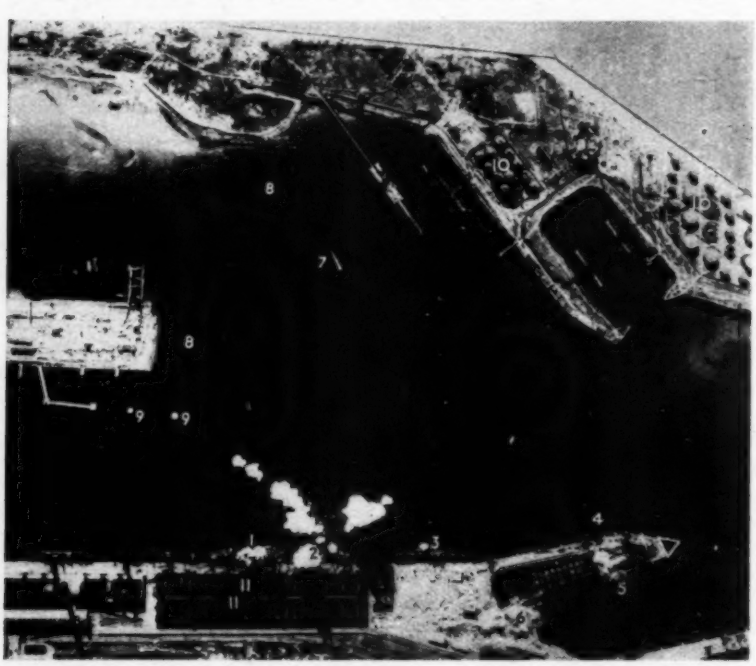
"Then, one night near St. Leger, after we had bombed the aerodrome at Douai, we met a huge Focke Wulf Condor, a four-engined transport. It had its navigation lights on, about to land. At only 50 yards range I put a good burst into the transport's belly. It was all that was necessary. The Condor gave out an enormous flash of light, burst into flames, and blew to bits."

FLIGHT WITHOUT FLAPPING: Carrier pigeons in their wicker cage off for a flight in a Catalina.

Occasionally, not too often, Air Force authorities mention the grand work of the aircraftmen who keep the machines in flying trim, but details are seldom published. A recent account from the Middle East tells of a feat by the men of a South African squadron, which would not easily be beaten. Working incessantly by day and night and barely stopping for food, the men repaired nine shell-riddled bombers in forty-eight hours.

The squadron had carried out a hazardous operation. One aircraft was lost. Two had their hydraulic systems shot away. One had a large hole in a petrol tank, and one aircraft had as many as sixty-five gashes where pieces of shrapnel had found their mark.

The commanding officer of the squadron, in his report of the action, said it would take at least a fortnight to effect repairs. Unknown to the officers the men held a private meeting, and started work. Fitters, riggers and air mechanics slogged incessantly. Sleep and meals were disregarded. In tents and lorries to preserve the black-out, they filed and welded throughout two nights until the job was done.



INVASION PORT ATTACK: Aircraft of R.A.F. Bomber Command, escorted by fighters, recently carried out a daylight raid on docks and shipping at Le Havre. This photograph, taken from one of the attacking bombers, shows bombs falling on the target during the raid and, also, damage inflicted in previous raids. (1) Bombs bursting on a 12,000-ton tanker. (2) Bomb bursting on a 5,000-ton merchant vessel. (3) Near miss; the ship is a 9,500-ton merchant vessel. (5) Bombs bursting on the quay and on a coastal tanker of 1,000-tons. (6) Bombs bursting on the quay. Damage inflicted in previous raids:—(4) Partly submerged vessel. (7) Dredger sunk and partly submerged. (8) Sunk vessels. (9) Sunk vessel marked by buoys. (10) Damaged oil-storage tanks. (11) Damage to roof of warehouse.

In the Mediterranean

IN the Mediterranean there has been a very heavy raid on Naples, on the night of October 21st-22nd, which lasted for five and a half hours. Many bombs which weighed nearly two tons each were dropped on the target area with devastating effect, and an area described as a quarter of a mile square in the target was left in flames.

A couple of nights before there had been a raid on Tripoli which lasted for three hours, and it, too, did tre-

ENEMY AIR LOSSES TO OCT. 25th.

	Over G.B.	Over Continent.	Middle East
Oct. 19	1	0	1
,, 20	1	0	0
,, 21	1	13	0
,, 22	3	0	4
,, 23	0	1	1
,, 24	1	7	1
,, 25	0	2	0
	7	23	7

Totals: North and Russia, 5,510; Middle East, over 2,145.

mendous damage to the port, which is the Italians' chief place of entry into North Africa. Convoys on the way to that port and to Benghazi have also been sedulously attacked by the Fleet Air Arm and the R.A.F.

On the same night as the Naples raid, the Fleet in the Western Mediterranean steamed up to Tobruk and sent naval aircraft over to drop flares on the enemy's positions on the escarpment outside the British position. The guns of the warships then shelled the position for half an hour or so. There was no interference with the operation by the enemy.

For some reason or other the activities of the opposed Air Forces in the fighting in Russia have not received much mention in recent communiqués from that front. One may presume that comparatively few independent actions are undertaken by either the *Luftwaffe* or the Red Air Force, though there has been a German "blitz" in the Eastern Ukraine. Both are busy over the battlefields, attacking the positions and troops of the other side. It would seem that the heavy bombers as well as those of medium category are employed on this close contact work with the armies in the field.

NOW ON THE MOSCOW FRONT: According to recent reports the R.A.F. Wing in Russia has moved its squadrons to the Moscow Front. Our photograph shows the conditions under which the ground crews are living.

The changes in the Russian High Command are interesting, but not enough details are known here to encourage comment on them. Marshal Timoshenko is now responsible for all the southern half of the Russian front, and part of his duty is to keep the Germans off the oil supplies in that area and from the region of the Caucasus. British supplies are already beginning to reach the Russians through Persia, and the greatest efforts are being made to improve that line of communication. Sir Godfrey Rhodes, an experienced railway authority, has been placed in charge of the work, and engines and other rolling stock are being sent out from Britain. New roads in Persia, too, are being made and existing ones kept in a state of good repair. It seems a very remote possibility that the German advance should interfere with that line before the winter sets in, though doubtless the enemy would like to send some heavy bombers against it, if they could be spared from other more immediate needs. Next spring, it is quite probable that hostilities in that part of the world will grow much more active.

In the meantime, it has been calculated that the R.A.F. raids over Northern France are detaining there about one-half of the available German fighters, and that must mean a very great help to the defenders of Russia; providing, of course, that the Russians have at their command sufficient fighters to hold the *Luftwaffe* bombers.

BRITISH AIR LOSSES TO OCT. 25th.

	Over G.B. A'crft.	Over Continent B'bns.	Ftrs.	Pilots	Middle East A'crfc.
Oct. 19	0	0	0	0	1
,, 20	0	10	2	2	5
,, 21	0	6	10	6	0
,, 22	0	5	0	0	0
,, 23	0	2	0	0	4*
,, 24	0	1	1	1	1
,, 25	0	0	0	0	1
	0	24	13	9	12

Totals: North and Russia, 2,910; Middle East about 445. *Two pilots safe.

In the Mediterranean there has been a whole succession of bombing raids on targets round Naples, carried out by the Middle East Command. Fires lit by the bombers one night have been found blazing still by the crews who have followed up on the following night. In due course, no doubt, we shall learn how the Neapolitans have reacted to these visitations. They can hardly have foreseen them on the day when Mussolini declared war on the Allies because France had collapsed, and the Italians thought that all was over except sharing the spoils.

WITH BOMBER COMMAND: The King and Queen inspecting a Blenheim IV during a recent visit to two bomber stations.

HERE AND THERE

Clean and Clever

HAVE you heard about the Canadian airman who was one of the lucky ones to broadcast to his folks, back home, on a greetings programme?

"Hello ma!" he called into the microphone, "I'm smoking 'Three Nuns' tobacco over here now—nun yesterday, nun to-day and nun to-morrow!"

Christmas Air Mails

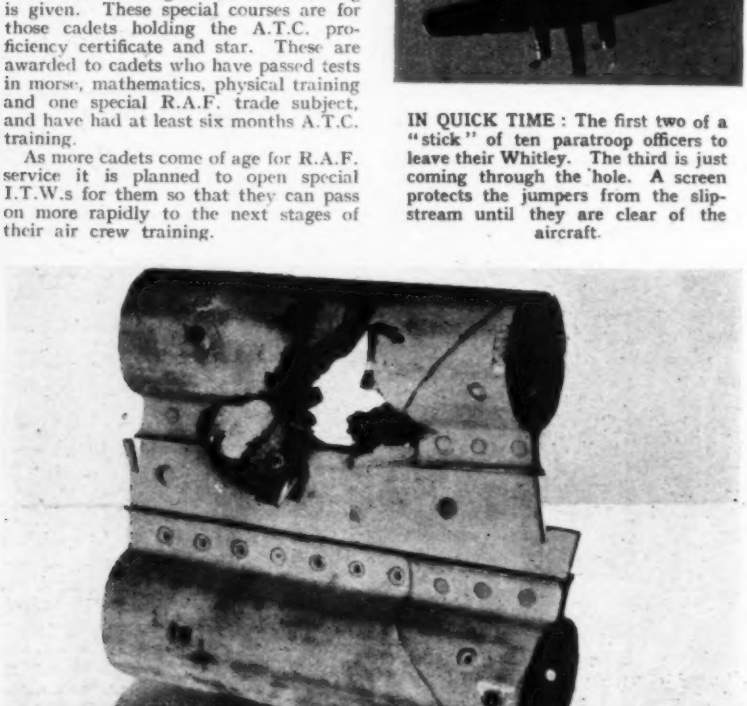
THE Postmaster-General wishes to remind the public that air mail letters for the Middle East, India, Malaya, Australia, New Zealand, etc., prepaid at the rate of 1s. 3d. per half-ounce, now have to be carried a large part of the way by sea, and the time of transmission is consequently much longer than in peacetime. War conditions make it impracticable to announce latest dates of posting in order to ensure delivery by Christmas, and the public are therefore urged to post their air mail letters as soon as possible.

A.T.C. Speeds Up Training

"STAR" cadets of the A.T.C. now entering the R.A.F. are having special speeded-up courses at Initial Training Wings—the instruction schools where the first stage of air crew training is given. These special courses are for those cadets holding the A.T.C. proficiency certificate and star. These are awarded to cadets who have passed tests in morse, mathematics, physical training and one special R.A.F. trade subject, and have had at least six months A.T.C. training.

As more cadets come of age for R.A.F. service it is planned to open special I.T.W.s for them so that they can pass on more rapidly to the next stages of their air crew training.

IN QUICK TIME: The first two of a "stick" of ten paratroop officers to leave their Whitley. The third is just coming through the hole. A screen protects the jumpers from the slip-stream until they are clear of the aircraft.



A Hurricane tailplane spar which has been shot through by a German cannon shell. From the size of the hole it was probably caused by a solid armour piercing projectile from one of the new 15-mm. Mausers.

Quantas to the Rescue

IT goes without saying that the operational staffs of British Airways are worked very hard during the war, and recently Quantas Empire Airways have come to their assistance by lending crews to help on the twice-weekly service between Singapore and Karachi. The Australian crews take their own aircraft as far as Singapore, and there change over to those of the British Corporation, flying them as far as Karachi.

Back to Civil Life

CAPT. R. J. GOODMAN CROUCH is relinquishing his post as Deputy-Director of Labour at the M.A.P. in order to become managing director of the Burnley Aircraft Co., an offshoot of Burnley Aircraft Products, Ltd. During the last war he was, at different times, O.C. of the Aircraft Depot at Dunkirk, which did repair and maintenance, so that he takes to his new job a great deal of practical experience. In the years between the wars he was also closely connected with airworthiness matters, a fact which should also stand him in good stead.

ADVERTISED GOODS

THE fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.

Dominion Air Appointment

ANNOUNCEMENT of the appointment of A. D. McLean, Superintendent of Airways of the Air Services Branch of the Department of Transport, to the position of Controller of Civil Aviation, has been made by the Canadian Civil Service Commission with the approval of the Hon. C. D. Howe, Minister with jurisdiction over the Air Services.

A Squadron Leader in the R.C.A.F. reserve of officers, Mr. McLean has been responsible to a large extent for the location and construction of most of the airports in Canada.

On the Russian Front

CANADIAN pilots, who have recently been taking an increasingly active part in the air war overseas, are included in the R.A.F. wing now in action against the Germans on the Russian front. This was revealed a few days ago by Wing Cdr. Roy McGregor, D.F.C., who recently commanded a Canadian fighter squadron in Britain. He is now in Ottawa.

"I haven't yet seen an R.A.F. squadron in which there are no Canadians," said Wing-Cdr. McGregor, "and with pilots coming from Canada at such a fast rate there will be more and more."

He added that American pilots are also taking an increasingly active part in the air war, and that, in addition to the American "Eagle" Squadron in action in Britain, a second American squadron is now active overseas.

"THE FLOWERS THAT BLOOM . . ."

Random Notes on Torque-reaction, or Aviation is the Coming Thing!

By W. S. SHACKLETON

IT is certain that "Mystified" must be even more so. He will know now that he cannot get the answer by integrating the opinions of the experts and then dividing the result by the number of the experts. He would merely get a lemon, and he would be lucky if he got a lemon these days!

We are all grateful to "Mystified." His innocent little question has aroused the most bitter controversy in modern times. But, what is more important, it has brought the aeronautical experts out of their lairs! Thousands of experts are arguing and then fighting all over the country. Much ink and blood has already been shed. We have come to blows ourselves with six experts. Fortunately, they were all smaller experts than ourselves. They all maintained that such details as gearing and counter-rotation made no difference to engine torque-reaction on the airframe.

A learned friend of ours, who also knows nothing about torque or anything, says that we are right! Our learned friend is a military expert. He writes a little weekly column headed "By our Military Expert."

Bows and Arrows

He is now studying the effects of torque-reaction on crossbow jacks. His wife confessed to us that 50 per cent. of military experts do not know. She says that the other 50 per cent. are of the same opinion. She says that the mental confusion of the military expert is wonderfully complete. She says that they become inextricably inextricable in their own counter-rotating verbosity. It also appears that there has been much fighting between Boy Scouts and A.T.C. youths over this vexed question of torque-reaction. The A.T.C.s naturally argue as aviation experts. They are about evenly divided on this question! It seems that their superior attitude annoys the Boy Scouts intensely. Following a heated argument on the Rotol contraprop, a Boy Scout was observed to attack an A.T.C., his arms contra-rotating rapidly, so that his balance would not be upset by torque-reaction!

Our own tame stressman says that the expert who claims he can roll (apply torque to) an aeroplane by pulling up on one side of his seat and pressing down on the other will secure disappointing results. He forgets that the seat is exerting an equal contra-torque. He would secure more positive results if he moved out towards the wing tip. Similarly, the expert who tries to lift himself off the ground with his bootlaces will not reach any appreciable altitude.

Our stressman Horace, who has analysed this latter problem in great detail, says that the net result will be to produce a tension in the bootlaces and the arms of the expert with a corresponding compression in the torso of the expert. That, as our stressman so rightly points out, is always assuming that the expert has a torso. Apart from which, an expert who hauls at his bootlaces brings his ear near the ground, and thereby places himself, as our great Prime Minister has pointed out, in an undignified and vulnerable attitude which, incidentally, reminds us that you ought to meet our tame stressman Horace!

Handicapped

Horace is a triplet, and he is not much to look at! He explains that this was due to neglect in his early years because he, being a triplet, only received point three recurring of the motherly care he would have received had he not been a triplet. Also, his nurse dropped him before he had time to set properly, and that places him at a disadvantage with his two litter brothers, one of whom is an eminent aviation expert with palatial offices in Piccadilly. He it was who invented the patented petrol tank for inverted flying. He placed the filler cap underneath. How many of your so-called *practical* men would have thought of that?

Horace's third triplet brother supports a high post in the Ministry of Labour, and also does no work. Mind you, strictly speaking, we do not see what all this has got to do with torque-reaction, but we are being paid the highest rates in journalism, and in these hard times one has got to eat.

Yes! You really ought to meet our tame stressman Horace! His favourite authors are Shakespeare and Damon Runyon, and that will show you the kind of guy he is.

Bitter Thoughts

Horace, moreover, is the sort of man who deals in plain facts and figures, and he suffers from no illusions. When he plants his tankard of bitter on the bar at the local he realises (as does the aviation expert) that the weight of that tankard is acting *downwards*. He also realises (as does *not* the aviation expert) that the bar is exerting a force of equal magnitude *upwards*, maintaining his tankard in a state of equilibrium.

Also, when he cranks up his 190— (late) Napier motor car (which is perhaps the only automobile which ever ran *anti*-clockwise looking at the radiator), he realises that he is applying a torque (although not, of course, a *pure* torque) to the whole automobile.

He also realises that the old car is exerting a counter-torque (although not, of course, a *pure* counter-torque!) on himself, and that this puts more load on his right foot than his left.

Our talented stressman also appreciates instinctively that those men who evolved contra-rotating props. for torpedoes did not do it merely for appearance, but to prevent the torpedo rotating itself, as it would do, about a single propeller.

And he also thinks of a Focke-Wulf helicopter with a pair of contra-rotating rotors, and he doesn't wonder why they turned in opposite directions. He is mildly mystified that anyone can conceive of applying a torque without getting a torque-reaction.

Twist and Countertwist

Our stressman has, in fact, what can only be described as "the engineering instinct," and he feels that anyone who can twist something without being twisted (unless he comes from Port Said) has gone most of the way to solving perpetual motion.

But when Horace speaks of counter-rotating airscrews he says that we are applying a torque to one half and an equal and opposite torque to the other. Therefore, he says, the *net* torque is zero and the *net* torque-reaction zero too.

And, Horace says, there are torques and torques. There is a torque in the crankshaft and even in the camshaft, but the torque that matters is the torque in the airscrew shaft or shafts, and the directions thereof. Torque is not power or energy any more than a force is energy. You must multiply torque by revs, among other things, to get energy, just as you must multiply force by distance. Of course, mind you, we do not profess to know whether Horace is right in all this, but that is what he says!

Horace says that torque-reaction does not worry a modern aeroplane much anyway. Unless, perhaps, it is a very small aeroplane with a very big geared engine. He says that the big idea behind these contra-rotating Rotols and De Havillands and Faireys is probably not so much that

"THE FLOWERS THAT BLOOM . . ."

they iron out torque-reaction as that they straighten out the slipstream. He says that a spinning slipstream, which always happens with a single airscrew, is *very, very* troublesome, and tends to cause swinging on take-off even more than plain torque-reaction.

Horace says that a *real* counter-rotating prop., each half absorbing 50 per cent. of the available power at the same r.p.m.—one right-hand and one left-hand—*must* straighten out the slipstream. If an expert asks "Why?" Horace says: "Well, if one blade goes in front of you to the right and then one goes in front of you to the left, and so on, which way does the slipstream twist if it doesn't come at you straight?" And our stressman says that if you have only one airscrew it makes the slipstream twist in the *same* direction as the way it is rotating, and he says this must not be confused at all with torque-reaction as it is nothing of the kind. In fact, it tends to make the aeroplane roll in the *same* direction that the airscrew is turning because it impinges (that's what Horace says) on fins and venturis and what-have-you's.

Shock Waves

A learned friend of ours, who also knows nothing about torque or anything, says that our stressman is indubitably right about all this.

Horace says that the only thing that worries him about contraprops are shock waves and their effects on this and that and one thing and another, including blades and gears. He calculates that if one airscrew tip doing 1,000 feet per second flicks past another doing 1,000 feet per second, they will pass each other at 2,000 feet per second. The mathematics are too high for us, but such a relative velocity is, as Damon Runyon would say, moving more than somewhat. Horace talks about compressibility effects at velocities approaching the speed of sound in air, and says that he has suffered from them himself. It appears that he was driving down the North Road in 1935 on his old Napier, doing (as the motoring experts so quaintly put it) a *genuine* 50, when a great car approached from the south doing a *genuine* 110. They passed at a *genuine* 160!

Horace says that the effect of that shock wave has to be felt to be believed! It seems that the great car was driven by a successful aeronautical promoter. He had collected the Phantom out of the deposit.

Geared Reverse

"But," says Horace, "if Roy Fedden and Rolls-Royce and De Havillands and Faireys and so many others are behind these contraprops why should I worry about shock waves? And," says Horace, "they wouldn't be doing 1,000 f.p.s. anyway!" "Also," warns our stressman, "just so that we don't start a lot more fights and arguments, it might be mentioned that two passing blades each doing 1,000 f.p.s. is not at all the same thing as if one blade doing 2,000 f.p.s. passed a stationary blade! No, Sir (or Madam)!"

Horace says that the best answer so far has been given by Mr. Granville Bradshaw, who is a practical engineer first and last, and has no illusions about anything connected with internal combustion engines. If there is no petrol in the carburettor, or if someone has immobilised the distributor, Mr. Bradshaw knows that he will get no torque out of that engine, and no torque-reaction either. And our stressman says that Mr. Bradshaw's explanation of the way a motor car engine (with unit gear box) heels over to the *right* when you accelerate in the forward gears, and how it heels to the *left* when you accelerate in reverse, proves that the direction of the torque-reaction has changed although the old crankshaft is still running in the same direction.

And then our stressman explains that if you are twisting up the shaft between the gear box and the back axle first one way on the forward and then the other way in reverse, you must be applying a torque-reaction in the opposite direction and of the same magnitude (them's his exact words!) to the gear box and consequently to the chassis. And he says that even if it isn't a unit gear box the same torque will be applied to the chassis, and as the chassis is connected to the engine it amounts to the same thing even if the engine is relieved of some loads on the indirects. And, continues our stressman triumphantly, we will now put that same automobile engine and its unit gear box straight into an aeroplane, only, of course, we must turn it back to front because the power usually comes out of the back end of a motor car engine, and on an aeroplane we can mostly do with it at the front end. We will design five propellers to use with that engine—four clockwise to suit the forward gears and one anti-clock for the reverse gear. Our top gear propeller will be the direct drive, and it will be just a little propeller running fast. Our third, second and bottom gear propellers will get bigger in that order because they will run slower in that order. And airscrew torque and torque-reaction will increase in that order, too, because we are delivering about the same power at lower revolutions.

Cranky

Now if we put the gear box into reverse and use my anti-clock propeller, the old prop. will turn the other way altogether and the old crate will tend to drop its right wing and not its left this time. Mind you, says Horace, the old crank is still turning in the same direction, but being an old crank it really doesn't know much about what is happening to the torque it is delivering!

And, says Horace finally, if you were big enough and strong enough and foolish enough to grab the front airscrew of a Rotol while it was rotating, the plane would tend to rotate in the opposite direction to that airscrew. Similarly, if you grabbed the rear airscrew the plane would rotate the other way. And if you grabbed both at once the motor would stop and the plane, not knowing which way to rotate, would not rotate! That is what Horace says, although, mind you, we do not profess to understand things of that kind ourselves.

Lemme see, where were we?

Oh, yeah! you certainly ought to meet our tame stressman Horace!

He says that Aviation is The Coming Thing!

BOOK REVIEW

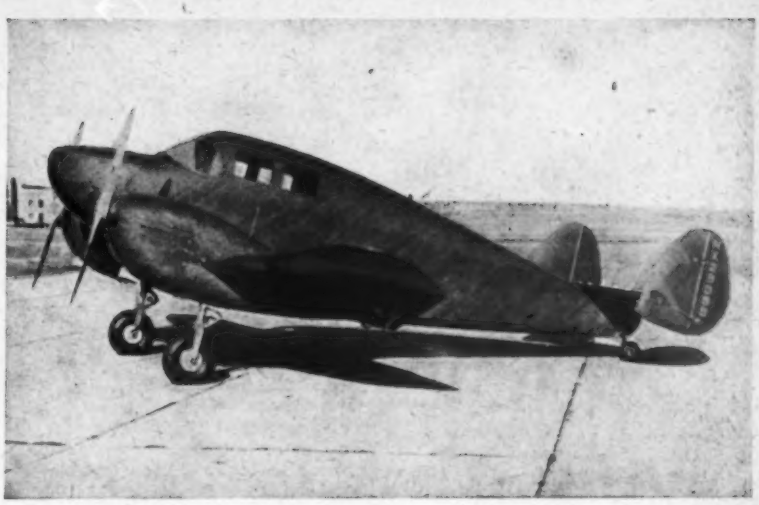
Air Navigation Simply Explained. By W. Myerscough Pitman; 6d.

ANY young man who is thinking of joining the R.A.F. or Fleet Air Arm for flying duty and has, as yet, no knowledge of how the airman finds his way about in the air would do well to invest the modest sum asked for this little booklet even if he does not intend to become a navigator. It is easy to imagine circumstances on active service when the simple information it contains might stand him in good stead. If he does intend to go in for navigation it will give him a most useful grounding in his future studies.

It begins right at the beginning explaining the map, then deals with the use of the magnetic compass, after which it passes on to long-distance flights, checking position by a running fix, dead reckoning, cross bearings and wireless bearings and finally explains how to allow for wind drift. All this is done in easily progressing stages and in terms any schoolboy can understand. For the complete beginner it would be difficult to improve on this 40-page booklet.

POST-WAR "FAMILY" AIRCRAFT

General Motors Executives Aim at Four-seater Model for £350 : Suitable Type of Engine Already on Test : Possibilities of New All-plastic Airframe for Mass Production



ALL-PLASTIC. The Langley Aviation Corporation's new moulded plastic plywood aircraft, which does not even employ nuts and bolts in the assembly.

FIRST whispers of a project, now being fostered by the executives of General Motors Corporation in America, to provide the post-war world with an inexpensive mass-produced "family" aeroplane have reached this country from Detroit.

The idea—which has been hailed by the Aviation Editor of the *Detroit News* as heralding the formation of "the General Motors of the Air"—came to light when a new type of aero engine was publicly exhibited among a display of GM defence products.

This was a four-cylinder, X-shaped, liquid-cooled two-stroke and, by virtue of its simplicity and low manufacturing costs, it represents a real move towards the low-priced private aircraft of the future.

The engine was merely labelled at the exhibition as being "suitable for use in trainers" and was rated at 185 h.p., but Mr. Charles F. Kettering, vice-president of General Motors, and Mr. Ernest R. Breech, also a GM vice-president and chairman of North American Aviation, Inc., who were found to be evincing particular interest in this unusual power-unit, subsequently admitted to a Press representative that it formed the nucleus of a post-war ambition.

It was realised that the major factor which determines the cost of an aircraft—especially the small civilian types—is its power-plant, and this new engine, developed over a period of years by the GM research laboratories, lends itself ideally to quantity production at very low cost.

Being a two-stroke, it has no valves, tappets or timing gear, so it starts with the advantage of mechanical simplicity; a centrifugal blower takes care of compression and, using ordinary motor car fuel, it is said to operate efficiently up to 20,000ft. It gives its normal 185 h.p. at 1,900 r.p.m. and 200 h.p. for take-off at 2,500 r.p.m. The weight is given as 400 lb., and long periods between overhaul—freedom from abuse being assumed—is an important claim made for it by Mr. Kettering. Standard motor car engine accessories are used wherever possible.

For nine years this engine has been under development by GM, and about 12 months ago it was installed in a Cessna high-wing monoplane for a thorough testing. It is now being flown in an aircraft of secret design which is believed also to be a GM development with the same object in view.

No particulars are available about this airframe, but this much is known: that for some time Messrs. Kettering and Beech have had in mind a really good four-seater private 'plane with a cruising speed in the region of 150 m.p.h. which could be put on the market in quantities for something less than $1,500 (round about £350), which is nearly one-tenth the price of such a machine to-day!

OVER NEW YORK. The all-plastic plane is here seen during a test flight. Two 65 h.p. flat-four engines are fitted.

Cheap But Strong

Simultaneously with the announcement of this engine and the avowed aims of the two GM executives comes news from New York of the successful flight of a new aircraft constructed entirely of moulded plastic plywood. Considerable recent progress has been made in plastics, especially in America, and this form of airframe, with the cheap, mass-produced engine of the type just described, might well form the basis of the post-war "family" model aircraft for the private owner.

Langley Aviation Corporation is responsible for the new all-plastic aeroplane, which, in this instance, is powered by two 65 h.p. "flat-four" engines of popular brand. There is said to be an unlimited supply of the cheap materials used, and the greatly advanced process employed also makes for simplicity in construction and, therefore, low production cost. These two factors, it is claimed, have combined cheapness with strength.

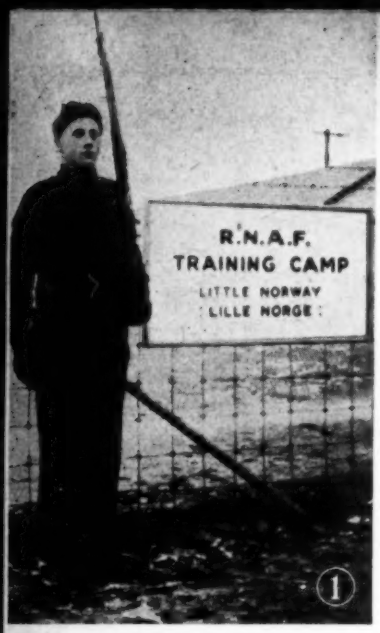
LITTLE NORWAY

Some Scenes from the Royal Norwegian Air Force Now in Training in Canada

A ROYAL Norwegian Air Force Training Camp was established at Toronto last year, in July, and is known over there as "Little Norway." After the campaign in Norway finished and King Haakon came to England, it was decided to build a new Air Force, as most of the machines used in the campaign had either been destroyed or were out of date. Many of the trained airmen got away and formed the nucleus of the new Force. They went to Canada, where they were joined by fellow-countrymen from all parts of the world, who volunteered and were sent to "Little Norway" to be trained. In addition, large numbers have escaped from Norway and after exciting adventures have made their way to Canada. At first the new Force was organised into two sections, one military and the other naval, but four months ago these were combined into the Royal Norwegian Air Forces.

The Commander-in-Chief of the combined Forces is Commander Captain Riiser-Larssen, the famous Arctic explorer. A short while ago he came to England with Major Øen and established headquarters here, and arrangements were made for the fully trained airmen from Canada to come to Britain to complete their last two or three months of operational training with the R.A.F. They now have their own squadrons.

Trainers, fighters and bombers were ordered, principally from the U.S.A. All expenses and training equipment is being paid for by the Norwegian Government. Norwegian airmen wear a darker shade of blue than our own R.A.F., with their own badges of rank, etc.



1. On sentry go at the entrance to "Little Norway."

2. In their quarters the naval trainees provide their own music.

3. An open-air lecture in front of the Fairchild primary trainers.

4. Three Curtiss Mohawks taking off in formation from the snow-covered aerodrome.

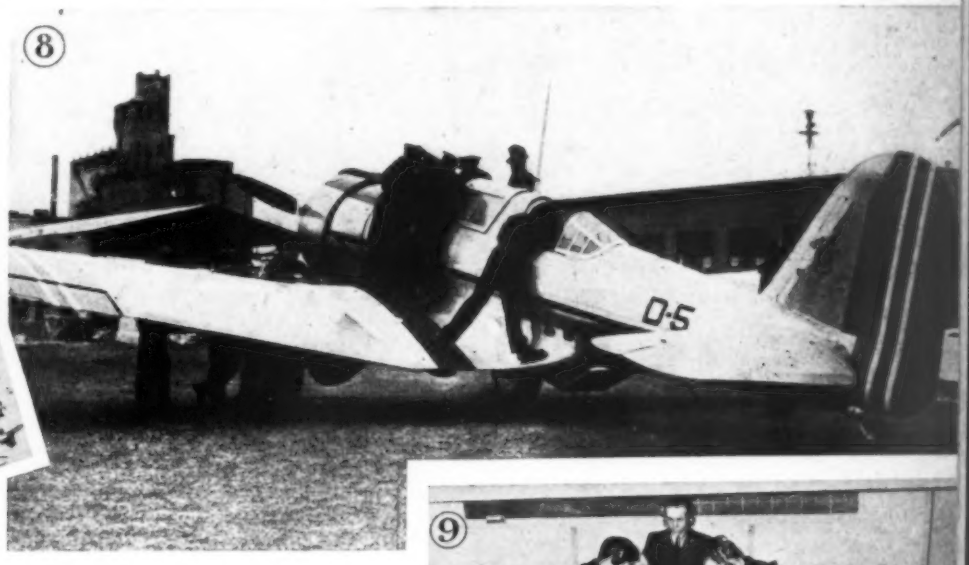
5. The Norwegians are at home in Canada's hard winter. Skiing runs and competitions are organised and proceeds go to the Norwegian Relief Fund.

6. A Stinson Reliant used for seaplane training.

7. For advanced seaplane training Northrop N.P.3 float-planes are used.

8. Military pilots do their advanced flying on Douglas 8A-5s.

9. A class taking morse instruction. The instructor is sitting at the far end of the table.



Topics of the Day

CONVERSION . . .

. . . Human and Mechanical : Making Use of Military Types and Military Pilots After the War

AFTER this war there should be far fewer of the genus peculiarly thought of as "the man in the street." Almost everyone—and certainly all the younger generation—knows something about the present-day flying machine. It is not very likely, therefore, that there will be any sudden idea in everybody's head that the Air Age has arrived, that we must all forthwith exchange our cars for aeroplanes, or that all these thousands of beautiful military types can be rushed into the air full to the very brim of complaining but excited and charmed passengers.

Everyone now knows that flying, even to-day, is not quite the easy and useful and swift affair that people were inclined to imagine it to be; that persons, however young and agile, do not fit very happily into bomb racks; and that getting from A to B in all weathers and at a moment's notice is still rather a matter for a team of experts—however quickly trained. The expertness has not been lessened; it has merely been shown during the war that quite a large percentage of young men *can* cope with the problems involved, and that concentrated training by really good instructors can reduce the time taken to learn the various "trades." Nevertheless, the average bomber crew is not necessarily experienced or skilful enough to be put in charge of a civil transport machine.

The fact that such things are generally known should help to make peacetime progress in civil flying much more reasonable and rational. Nobody should have any false ideas, yet nobody should have the impression that there is anything in the way of a superman about a transport pilot—and certainly not about a private pilot. The heroics will, thank goodness, have gone, and there will be thousands of young people who are willing and ready to fly either their own aeroplanes—if these are available at the right price—or to fly comfortably and happily in the aeroplanes offered by the air transport companies.

High Finance

If only this war doesn't reduce us all to cave and tree-top men, and if only the financial experts will become a little more rational, the world may still be a very good and pleasant place in which to live. Maybe after finding that it is possible to go on spending (the term is meaningless since no blocks of gold or other shibboleths are now involved) at the rate of about ten million pounds a day without any noticeable change in the standard of living, the experts will permit "money" to be "spent" in reasonable quantities on really useful projects without blathering about bankruptcy and other nonsense. There isn't such a thing as bankruptcy except in the minds of a lily-livered public, and, after all this, the public should be anything but lily-livered. A country or a business goes bankrupt when the majority of the people both inside and outside lose faith in its ability to get on with the job and produce results.

Nevertheless, it should be possible to do something to a great number of the present military type to make them fit for the carriage of passengers or, at least, of freight. Nearly all modern aeroplanes are easy and safe in their characteristics, some of them are quite economical if they are flown to peacetime standards (with the vast reserve of power treated *as* a reserve and not as power to make the things go unnecessarily and uneconomically fast over short distances), and a few of them are fairly roomy once all the devices have been taken out and upholstery used with suitable imagination to cover up the knobbly bits. Even a fat spar in the centre of a fuselage can be made to look like something else, and there is no earthly reason why passengers should not quite naturally be made to enter from different ends according to their seating position.

But all this is a matter for due and careful consideration if and when the time comes. The point I want to make is that a rational view of the whole matter can produce results at comparatively low cost, and there will be no need to scrap all the aeroplanes which are not actually wanted for policing purposes. We certainly must not have any violent reduction in expenses which will cause a whole lot of very useful aeroplanes to be put on what market there is at scrap prices.

Using Available Material

Those who are old enough will remember what happened at the end of the last war. Admittedly, the types then in use were not as practical for general purposes as some of them are now, but even so I can well imagine a sort of panic economy scheme causing the most enormous losses in effort and material. Even if it costs millions a month instead of millions a day, let us devise a scheme by which every prospectively useful airframe and engine *is* put on one side and maintained for use and not just left to rot. There will obviously be a tendency to drop everything and to sit back with a sigh when this thing is over. Well, let everyone have a fortnight's holiday, but for goodness sake let us make use of the available material before it has all melted away. And by material I mean human as well as other more concrete material—designers, workmen and pilots. The world will be a difficult enough place without an unnecessarily sharp relapse.

I think it is fairly clearly understood by the powers that be that there must be no "relapse" where manpower is concerned either. Obviously it will not be possible to make use of all the flying and other personnel at present in the Air Force, but it should be possible to make use of them at least until they can find themselves a place in civil life. Since the world will not automatically become a perfect place, a large Air Force will be necessary for many years to come, but those experienced and picked pilots and radio operators who care to make flying a career in peacetime could be "lent" to the national air transport concern. The important thing will be to hold such people in useful work and practice until they *are* needed, and not to release them immediately—leaving them to go rusty in some unsuitable civil job. It may be a year or two before they *can* be used, and during that period they must be kept busy and happy and not given the idea that they are just wasting their time.

The future, in fact, must be *planned*. INDICATOR.

TO ECONOMISE IN PAPER

OUR associated journal *Aircraft Production* for November appears with a smaller page size in consequence of the need for national economy in the consumption of paper. Increased editorial space provides opportunities for the fuller exposition of the technique of practical aircraft production in all its phases, now so necessary due to the dilution and the advent of the male and female trainee. The new-size November issue is now on sale, price 1s. 6d., and the month's feature article deals with the production of the Blackburn "Botha."

Other subjects treated practically include advice to foundrymen on the production of plaster patterns to achieve economy; the preparation of lightly stressed parts from cellulose-fibre laminations; methods of ensuring interchangeability of aircraft parts; the manufacture of moulded Perspex panels for transparent enclosures, and a review of modern machine tools and small tools.

"Who's Who in Production," an entirely new feature for *Aircraft Production*, commences with this issue also, and embodies portraits and short pen pictures of leading personalities engaged in what has become the greatest of our war efforts.

Tenth of the Second Series

FRIEND or FOE?

Rival Twin-engined Fighters

Beaufighter and Fw 187

BEAUFIGHTER : Typical Bristol fin and rudder; note trimming tab and tail lights. Tailplane tapers on trailing-edge; round tips.

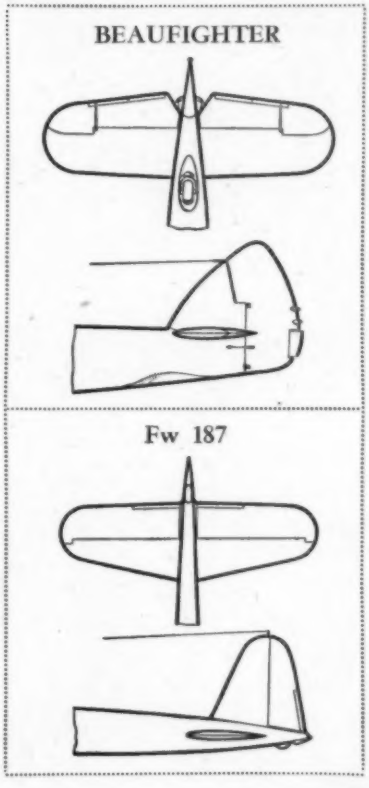
THE Bristol Beaufighter, as everyone knows, functions chiefly against raiding bombers at night, when the people most likely to see it are the members of other air crews—theirs or ours!

The Focke-Wulf Fw 187 is one of the latest of German twin-engined fighters, and although one rarely, if ever, hears its name mentioned as having been encountered during our daylight sweeps over enemy-occupied territory, it is more than likely that it fulfils a similar function to that of the Beaufighter at night.

Now while it is improbable that any spotter worthy of the name would confuse these two aircraft in daylight, since there is a marked difference in their size, wing plan and engines, it is fairly easy to imagine that members of a British air crew, catching a dim glimpse of a twin-engined fighter somewhere ahead of them in the night sky, might have a certain difficulty in deciding quickly enough whether to press the button or not. Even in a moonlit sky the differences between Beaufighter and Fw 187 are far less obvious when viewed from astern, so a comparison of their respective tail units should be distinctly useful.

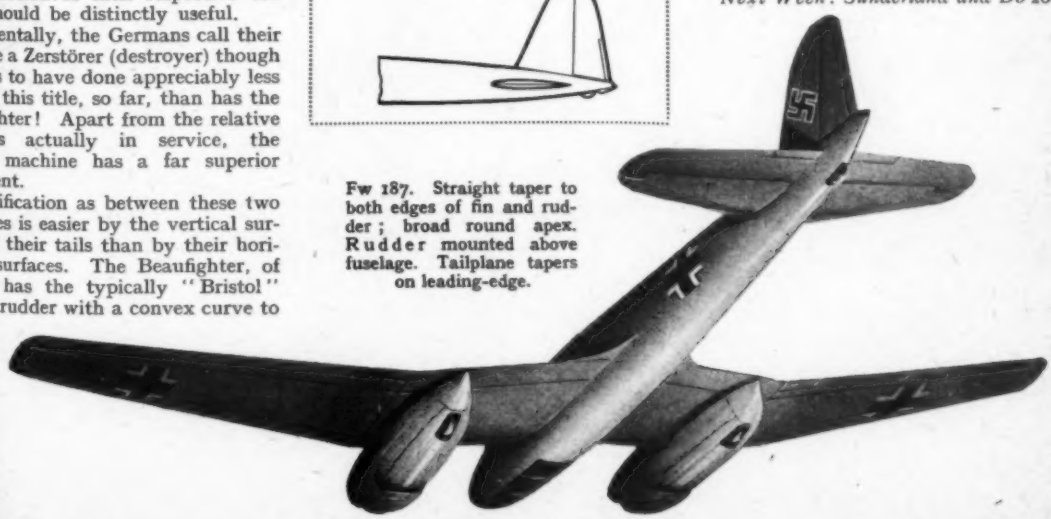
Incidentally, the Germans call their machine a Zerstörer (destroyer) though it seems to have done appreciably less to earn this title, so far, than has the Beaufighter! Apart from the relative numbers actually in service, the British machine has a far superior armament.

Identification as between these two machines is easier by the vertical surfaces of their tails than by their horizontal surfaces. The Beaufighter, of course, has the typically "Bristol" fin and rudder with a convex curve to its leading edge and the small, almost pointed apex. The Focke-Wulf, however, has a straight taper to both edges and a much broader curved apex. Moreover, the rudder of the German machine does not extend down to the base-line of the fuselage as does that of the Beaufighter, but shares a common base-line with its fin.



The main difference between their tailplanes is that on the British aircraft it tapers on the trailing-edge only, and on the German machine on the leading-edge only, both having well-rounded tips. Being distinct opposites in this respect, the difficulty will be to remember which is which. Fortunately, however, the Beaufighter has a "bite" in the centre of the trailing-edge where the elevators are cut away to permit rudder movement; the Focke-Wulf's tailplane has no need of this since its rudder is wholly on top of the fuselage. This will be the more easily remembered if one thinks of the British fighter (by virtue of its heavier armament) as having more "bite" than its rival. Both tail wheels remain partly visible when retracted.

Next Week: Sunderland and Do 26.



Fw 187. Straight taper to both edges of fin and rudder; broad round apex. Rudder mounted above fuselage. Tailplane tapers on leading-edge.

Top, left.—An airman of the photographic section mounts a camera in the Lysander.

Centre, left.—A glimpse of the photographers at work inside a mobile darkroom. The man on the left is printing from a roll of film.

Top, centre. — Army liaison officers studying air photographs. Overlaps may be seen in relief with the aid of a stereoscope.

Centre, above. — Communication with the dark-room staff is by voice-pipe. A runner with a film magazine is asking for admittance.

Bottom, left. — An aerodrome scene showing pilot of a Westland Lysander handing his report to the liaison officers. On the right is a mobile "office," and a crash helmeted despatch rider stands by in the background.

ARMY CO-OPERATION COMMAND

Some Scenes Which Show How Close is the Liaison Between the Army and the Royal Air Force in the Youngest Command

ALL squadrons of the Army Co-operation Command are under the operational control of the Army Command with which they work. Training and aircraft supply are matters for the R.A.F. and Air Ministry respectively and the pilots are drawn from the two Services in equal proportions.

Top, right.—Supplies are dropped by parachute to troops cut off from the main body.

Centre, right.—Troops unloading a container. A soft aluminium hollow nose absorbs the landing shock.

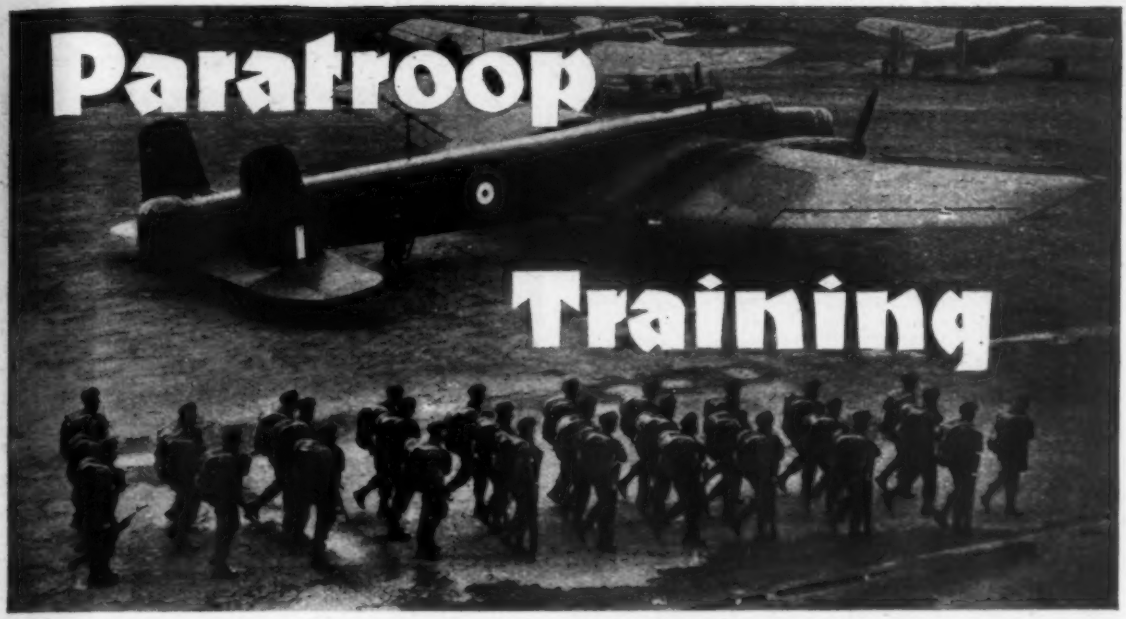
Centre, left.—Parachute supply containers are interchangeable with bombs and are carried on the special stub wings of the Lysander.

Bottom, right.—An army sergeant lecturing aircraftmen on the elements of aerodrome defence. Each squadron has to be able to look after itself in the field.

TALLY HO!

By Robert Aitchen.

LAST FLIGHT OF A GALLANT AIRMAN: At dawn on October 14, Pilot Officer David Usher Barnwell, D.F.C., with other fighter pilots from Malta, engaged enemy aircraft which were attacking the island. The control room heard his voice saying: "Tally Ho !-Tally Ho !-Got One !-Got One !" Five minutes later his voice sounded again: "Baling out; engine cut; am coming down in the sea." A rescue launch searched all day until dark, but found no trace of the pilot. David Barnwell was the youngest son of Frank Sowter Barnwell, for many years Bristol's chief designer. His two brothers were both killed in service with the R.A.F., one with Bomber Command and the other with Fighter Command.



Paratroop Training

Khaki and Blue Work Together : Training the Troops : Old Tactics But New Transport

Illustrated by "Flight" Photographs

THE training of parachute troops is an example of perfect co-operation between men in khaki and men in grey-blue. The Army and the Air Force have to work together in unison, and they do so. When a Brigadier at the War Office was given command of a parachute unit, he was asked if he would like a liaison officer. He replied that he did not know French and did not understand the word "liaison," but he undertook to work with the R.A.F. in the common task of defeating the enemy—and that is the best spirit that the fighting forces can have. The said Brigadier explained to a representative of *Flight* that, so far as the principles of tactics go, there is nothing new about parachute troops. He compared them to the Light Infantry raised and trained by Sir John Moore, of Corunna fame. The only novelty was the means of transport, of getting to the place where the men were able to fight with the best effect. The men he had were the pick of the Army, all volunteers, and all hard and tough. They certainly looked it, but there was nothing about them suggestive of the bloodthirsty ferocity with which the Blond Beast conducts war. They were cheerful and merry, typical English and Scottish soldiers; but one felt that it would not be good to be up against them in a fight.

The part of the R.A.F. in this combination is to provide the aircraft and to land the men at the appointed place—or, more accurately, to give them the opportunity to land themselves. It may also extend to maintaining them for a reasonable time with rations and ammunition. That sounds a fairly straightforward sort of job, but actually there is a good deal more in it than that. The R.A.F. had to develop the equipment for dropping and all the gadgets connected therewith, and to see that the men can use them properly. The Russians and Germans had some experience before the war, whereas we had to start from scratch—though we were able to profit by the experience of the others. But it is the British way to start last and turn out something better than anybody else has done. Our authorities are sure that the type of parachute which we have developed for this work is the best in the world, and so is the rest of our equipment.

SOLO EFFORT : A paratrooper makes a practice jump.

The Germans used Ju 52 passenger machines for their parachute troops. We have taken the decision not to copy them in this respect, so we use bombers (Whitleys were what I saw) with a hole cut in the bottom of the fuselage. There is a divergence of opinion between those who have learnt to drop through a hole and those who have been taught to drop from a door, and each school is inclined to favour its own way and to think that the other would be terrifying.

Most Continental nations have started parachute training by dropping a man under control from a tower. The Polish parachutists in this country have had a tower erected, but our own men and the Free French have not done so as yet.

PARATROOP TRAINING

HOW IT SHOULD BE DONE : An excellent example of dropping close together. These are two of a "stick" of ten officers.

EXCHANGE OF COURTESIES : The flying side of the programme is in the hands of the Royal Air Force. The first and second pilot of the Whitley are shown chatting to their section of paratroops before emplaning.

Our course of training is as follows. First the men do a period of special physical training to get their legs strong and their muscles supple. This includes wrestling and a certain amount of jiu-jitsu, which may come in handy when making an unarmed enemy a prisoner. I saw some very pretty bouts. Then the men are taught all about the parachute, how it works and why, and learn to pack it. Normally all the drying and packing is done by W.A.A.F. girls, and very well they do it, but it is a good thing to teach the men who will entrust their lives to a previously unfamiliar contraption to know all about the art of packing. All this gives them confidence in their parachute. At the same time the men are all taken up for a number of flights, so as to get them used to the air and to be inside a bomber. From a dummy fuselage they drop through a hole on to a mattress below. By means of swings in a hangar they learn to get used to the sensation of dangling from ropes, and learn to control the swing and check the motion. They learn the drill of jumping in the proper order, of getting

HOW THE QUILTER STATICHUTE OPERATES : Left to right—(1) The complete chute with the static line which is attached to the aircraft. (2) The static line has been extended and is about to break the ties of the outer case. (3) After the outer case has opened, the inner case is shown to be held by two further ties to the main webbing suspension near the shoulder blades. (4) With these two ties broken the shroud lines start unfolding (see bottom of next page).

MASS DESCENT : A formation of six Whitleys in the process of dropping a batch of 60 paratroops in quick time from 500ft. The paratroops nearest the camera have been dropped by two Whitleys which have gone out of the picture. The right-hand Whitley has just begun disgorging, while its fellow on the left is due to start immediately. In the distance are two more Whitleys coming up. The Lysanders are mere interlopers with camera men aboard.

rid of their parachute harness, of spilling the air from the canopy after landing (so as to avoid being dragged), and they also learn the technique of falling without getting hurt. This, I was told, is quite different from the technique of a hunting man when taking a toss from his horse. Acrobatics, not aerobatics, seem to enter a good deal into the business. When a man is really fit and well trained, it is surprising what rough landings he can take without harm to himself. Of course, ankles get sprained occasionally, but not very often. The men wear boots with very thick rubber soles, and one result of this is that when marching in them and with their special helmets covering their ears, they find it very difficult to keep step. This is but a minor point. The great thing is that the soles reduce landing shocks.

The first jumps made in training are from a captive balloon, with an instructor standing below and shouting instructions up to the man about how to manage his shroud lines so as to land correctly and to correct the swing. Then, when the man has got over his initial distaste for hurling himself into space, which is instinctive at first in a human being, however venturesome, he makes a few individual drops from a bomber. Dropping in groups is the last stage of training, and it requires very good drill, for the men must land close together if they are to be effective on the ground. When an aircraft is travelling at three or four miles a minute any delay between the drops will spread the men out unduly and so waste precious time.

What they do after they have landed, how they collect arms and equipment from canisters dropped separately, each with its own parachute, is a matter of Army

(5) When the shroud lines are fully extended (not shown here for clarity) another two ties on the mouth of the bag break and—(6) the silken canopy emerges. Finally, when the whole canopy has left its case—(7) a last tie at the apex is broken and the parachute is free.

PARATROOP TRAINING

JUMP TRAINER: (Left) In order to clip fractions of seconds off the time taken to jump, numberless dummy jumps are made through a hole on to a mat. (Above) Briefing the paratroops and air crews.

platoon drill. The Army authorities say that it is as simple to learn as any other form of platoon drill, but, of course, it does not concern the Air Force.

The Air Force's share in the operation does not end when the men have been trained and properly equipped. The task of getting the desired number of men to the right place is one of no little complexity. Even the best navigators in bomber crews sometimes fail to find their targets, but the whole fleet of machines which carry the troops and their equipment must arrive at the right place at the right time if the enterprise is to be a success. The flight may have to take place at night. Even in moonlight it may be very difficult to identify the field where the troops must land, and when it has been found each flight of bombers must arrive over it at the right second. The first men to land are very helpless if attacked by the enemy before they have mustered and formed up, so absolute timing by the airmen is highly important. Careful staff work is needed, and at such work Royal Air Force staff officers are good.

The troops, of course, are prepared to take risks, as all soldiers are; but they feel confident that, so far as is humanly possible, the Air Force will not (figuratively) let them down. Literally, they will let themselves down, only too delighted to put their careful training to the proof in the face of the enemy.

(Above) **MESSAGE CARRIER:** Homing pigeons are carried in order to send back news of success or otherwise of the operation.

(Right) **ALL ABOARD FOR—?** A section of ten paratroops emplaning on a Whitley while the R.A.F. air crew watch their charges aboard.

THE AIRCRAFT ENGINEER

WING-WEIGHT ESTIMATION

A Practical Method Which Takes Into Account Variations Due to Wing Loading, Span, Thickness, Taper Ratio, Load Factor and Material

By C. R. ENGLEBRY*

THIS paper, presented at the thirteenth dinner meeting of the Society of Aeronautical Weight Engineers at Los Angeles in July, outlines a quick and accurate method of estimating wing weight. The author outlines the effect of various items which influence the weight, and develops a basic formula whereby all conditions are considered. The method, although complex in derivation, is simple to apply.

THE problem of estimating wing weights is a very complex one, for no other major structural item of an airplane has so many varying factors that affect weight. There is a definite need for an estimating method, based on these varying factors, that can be applied to any type of wing with reasonably accurate results. The attack of the problem must be based, however, on logic, and be as simple as possible within the limits of reasonable accuracy. In other words, a compromise should be made between the simplest method of wing estimation, an estimate based on a similar model already constructed, and the most complex method, a complete stress analysis of the wing.

The purpose of this article is to present a method of wing weight estimation that is logical, practical, accurate, and, although complex in its derivation, simple to apply. Basically, the method was evolved from an equation of the bending material required to sustain the airloads. It is applicable to all types of airplane, and it accounts for weight variations due to wing loading, span, thickness, taper ratio, load factor, and material. This method is also adaptable for use with particular types of structure instead of particular types of airplanes. Essentially, this means that a broader scope of estimates can be made; for most modern airplanes employ similar types of wing structure.

The three steps that comprise the solution to this method of wing weight estimation are as follows:

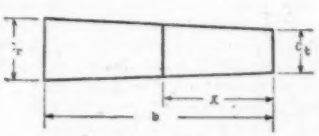
1. Derivation of a wing weight formula based on the material required for bending loads.
2. Tabular form of the formula used to solve for "N" which is the ratio $\frac{\text{Bending Material Weight}}{\text{Wing Weight (Less Ail. and Flaps)}}$.
3. "N" and bending material weight found in (2) for known ships plotted against basic wing dimensions and design criteria.

Derivation of Wing Weight Formula

Several assumptions have been made in arriving at this method for estimating wing weights:

1. Bending loads are the design criteria. They are based on air loads, tail loads, and dead weight loads.
2. An average allowable stress of 35,000 lb./in.² has been used in determining the material required for bending.
3. All-metal, box-beam, uniformly tapered wings form the basis for this analysis.

The following is a detailed derivation of the formula:



Basic wing plan form.

1. The running load on any element, X distance from the wing tip, is equal to the chord at Sta. X multiplied by the wing loading in lb./in.². The equation for the running load at X is as follows:

$$L_x = K\left[C_t + \frac{X}{b}(C_r - C_t)\right]$$

Where
K = Wing Loading in lb./in.²
C_t = Tip Chord in inches
C_r = Root Chord in inches
b = Span in inches
X = Span from tip in inches.

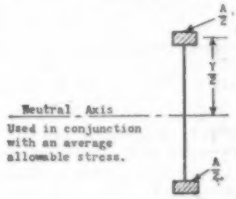
2. Integrating the load formula will give the shear formula,

$$S_x = K\left[C_t X + \frac{X^2}{2b}(C_r - C_t)\right]$$

3. Subsequently, integrating the shear formula will give the moment equation,

$$M_x = K\left[\frac{C_t X^2}{2} + \frac{X^3}{6b}(C_r - C_t)\right]$$

4. The bending material area (A) may be evaluated by substituting $f = \frac{M_x C}{I}$ in the moment equation when f is written in terms of A, as follows:



Used in conjunction with an average allowable stress.

$I = 2 \times \frac{A}{2} \times \frac{Y^2}{4} = \frac{AY^2}{4}$

f = Avg. Allow. Stress $= \frac{4MC}{AY^2}$

When $C = \frac{Y}{2}$, f is at the approx. average value.

$$f = \frac{2M}{AY} \text{ or } A = \frac{M}{.5\,fY}$$

5. Since "Y" is the average depth of bending material between centroids of the upper and lower surfaces, its equation may be written in terms of wing span,

$$Y_x = T_t + \frac{(T_r - T_t)}{b} X$$

Where T_t = Avg. thickness of tip chord.
T_r = Avg. thickness of root chord.

6. Hence, substituting "A_x" and "Y_x" in equation 3 will give the bending material area at "X" at 1C load factor.

$$A_x = K\frac{\left[\frac{C_t X^2}{2} + \frac{X^3}{6b}(C_r - C_t)\right]}{.5f\left[T_t + \frac{(T_r - T_t)}{b} X\right]}$$

7. Multiplying "A_x" by the ultimate load factor (L.F.), a factor "Z" to correct the wing load for tail load and wing weight, the aluminium weight constant .10, and dividing by a factor "N" representing the ratio of bending material weight to total wing weight, will result in the ultimate formula for the total wing weight in lb./in. at any station "X":

Wing weight x/side

$$= \frac{\text{L.F.}\ Z\ .10\ K}{.5\,Nf}\left[\frac{\frac{C_t}{2}X^2 + \frac{X^3}{6b}(C_r - C_t)}{T_t + \frac{(T_r - T_t)}{b} X}\right]$$

* The author is weight engineer of the Lockheed Aircraft Corporation

For simplicity in integrating the above formula for the total wing weight over a span " b," the term $\frac{\text{L.F. Z 10 K}}{.5\,Nf}$ will be designated as " D."

8. Wing weight/side $= D \int_{X=0}^{X=b} \frac{\frac{C_t X^2}{2} + \frac{X^3}{6b}(C_r - C_t)\,dx}{T_t + \left(\frac{T_r - T_t}{b}\right) X}$

9. After integration the wing weight formula is as follows:

$$\text{Wing weight/side} = \frac{D\,(C_r^3 - C_t)\,b^3}{18\,(T_r - T_t)} - \frac{Db^3}{(T_r - T_t)^4} \times \left[\frac{(C_r - C_t)\,T_t}{6} - \frac{(T_r - T_t)\,C_r}{2}\right]\left[.5\,(T_r - T_t)^2 - T_t\,(T_r - T_t) + T_t^2\,(\text{Log } T_r - \text{Log } T_t)\right]$$

Tabular Method for Finding Estimating Curves

Since the use of this formula is somewhat cumbersome, a tabular method (Fig. 1) was set up for calculating the wing weights. Weights found by this method were in terms of $\frac{\text{Bending Material Weight}}{N}$. With a set of airplanes whose wing weights (less flaps and ailerons) are known, the values of " N " can be found and plotted as a straight line variation with the ratio $\frac{\text{Bending Material Weight}}{\text{Gross Weight}}$.

Once the " N " curve is determined an actual wing weight estimate may be made by solving for the bending material by use of the tabular form, finding " N " from the " N " curve, and then solving for the wing weight from the relation

$$\frac{\text{Bending Material Weight}}{N} = \text{Wing Weight},$$

where the wing weight does not include flaps or ailerons.

FIG. 1
TABULAR METHOD OF WING FORMULA SOLUTION

No.	Symbol	Item	Model	Model
		Extent of Bending Mat.—Per cent. Chord		
		Max. Airfoil Thick. at Root.—Per cent.		
		Max. Airfoil Thick. at Tip.—Per cent.		
		Avg. Thick. to Contour.—Root		
		Avg. Thick. to Contour.—Tip.		
	W	D.G.W. × Margin of Safety		
	L.F.	Ultimate Load Factor		
	K	Wing Loading—lb./in.^{2}		
	Z	$\frac{W \times 1.02 - \text{Wing Weight}}{W \times 1.02}$		
	A	Material Wt.—lb./cu. in.		
	f	Average Allowable Stress		
	N	$\frac{\text{Bending Mat. Wt.}}{\text{Wing Wt.}}$		
	b	Span (in.)		
	C_r	Root Chord (in.)		
	T_r	Avg. Thick. to Cent. (in.)		
1	C_t	Tip Chord (in.)		
2	T_t	Avg. Thick. to Cent. (in.)		
3	D	$\frac{\text{L.F. K Z A}}{.5\,f\,N}$		
4		$(C_r - C_t)$		
5		$(T_r - T_t)$		
6		$(T_r - T_t)^2$		
7		$(T_r - T_t)^4$		
8		Log T_r (Base e)		
9		Log T_t (Base e)		
10		b^3		
11		T_t^2		
I		(3 × 10 × 4) ÷ (18 × 5)		
II		(3 × 10) ÷ 7		
III		(4 × 2) ÷ 6		
IV		.5 × 5 × 1		
V		.5 × 6		
VI		2 × 5		
VII		11 × (8 − 9)		
VIII		II (III − IV) (V − VI + VII)		
IX		2.1 × (I − VIII) = Wing Wt./Ship.		
X		Act. Wing Wt.—Less Flaps and Ail.		
		$N = \frac{\text{IX} \times N}{X}$		

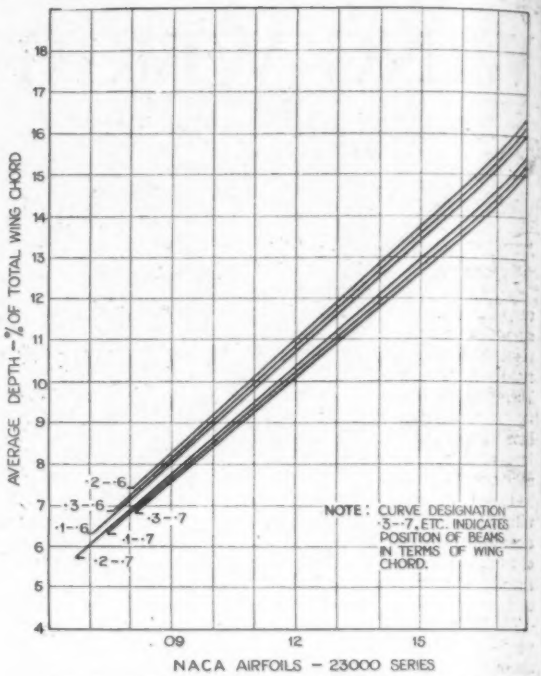


Fig. 2. Average depth curve NACA 23,000 airfoils.

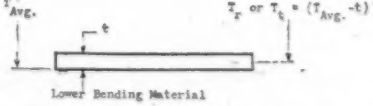
Several items should be explained in the use of the tabular form.

1. Flange material — per cent. chord is the width of the box beam construction, chordwise.

2. " Z " corrects for tail load and wing weight.

3. 35,000 lb./in.^{2} was taken as the average allowable stress for Lockheed models.

4. " T_r " and " T_t " are the average depths of the wing between beams at the root and tip, respectively, less approximately the depth of half the total bending material.



See Fig. 2 for estimating average wing section thickness for NACA 23000 and NACA 4400 series airfoils between any percentages of the chord desired.

5. Item VIII of the tabular form is multiplied by two for the total wing weight and then by 1.05 (an approximation only) to take care of normal torsional load requirements. (When estimating the weight of a boom-type airplane a separate allowance should be made for the additional torsional loads imposed on the wing.)

Actually, some features of this method could be simplified, but since this method was to be logical, all variables, except two, consistent with the line of reasoning used in arriving at this method, have been included. Both the effect of fuselage weight on the wing and a separate inclusion for ineffective bending material have been successfully omitted as variables to be considered.

So far no mention of any corrections for nacelles (if any) or fuel loads have been made. Rather than complicate the tabular form, separate calculations may be made to take these items into account. They are as follows:

1. Bending Mat. Weight/ship $= \frac{\text{Fuel wt./side} \times \text{arm} \times .10 \times \text{L.F.} \times b_t}{.5 f\,T_r}$

WING-WEIGHT ESTIMATION

Where: Arm = Moment arm from centroid of fuel load-side to centre line of airplane.
b_f = Span of fuel for one side of ship only.
T_r = Avg. thickness of box beam at centre line of ship.

2. Bending Mat. Wt./ship
$$= \frac{\text{Nac. Wt./side} \times \text{Arm}^2 \times \text{L.F.} \times .10}{.5f\,T_r}$$

3. Total Bending Mat. Wt./ship
= Result of tabular form less above two calculations.

The "N" curve (Fig. 3) is based on corrections for both fuel and nacelle loads. Wing estimates for single-engine ships made from the Lockheed curves should be corrected for not having nacelles. For light ships (up to approximately 20,000 lb. gross weight) multiplying the Lockheed curve estimate by 1.1 will give a good approximation. It would be desirable, however, to have estimation curves drawn for single-engine ships only.

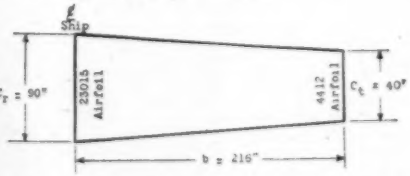
Short-cut Method of Estimating Wing Weights

Once the calculations have been made by the tabular method for bending material weights and values of "N" for the known ships, two curves can be drawn from which all subsequent wing weight estimates can be made. Bending material weight plotted against

$$\frac{b^2 \times \text{Gross Weight} \times \text{L.F.} \times 10^{-6}}{t_a}$$

where $t_a = \frac{T_r + T_t}{2}$, will form a straight line curve, and "N" plotted against $\frac{\text{Bending Material Weight}}{\text{Gross Weight}}$ will form a straight line curve. Hence, for any proposed ship all the factors required are usually known for finding the bending material weight from the curve and then dividing by "N" from the "N" curve for the estimated wing weight.

Example: Assume a pursuit ship of the following wing dimensions and basic design criteria:



L.F. = 12, gross weight = 6,500 lb., assume beams at 30 and 70 per cent. of wing chord.

1. $T_r = (.1261 \times 90) - 1.2 = 10.15$in.; $T_t = (.101 \times 40) - 1.2 = 2.84$in. where .1261 and .101 are from Fig. 2 using the .3-.7 curve, and 1.2in. is the assumed depth of either upper or lower bending material.

2. $t_a = \frac{T_r + T_t}{2} = \frac{10.15 + 2.84}{2} = 6.5$in.

3. $\frac{b^2 \times \text{Gross Weight} \times \text{L.F.} \times 10^{-6}}{t_a}$
$$= \frac{216^2 \times 6500 \times 12 \times 10^{-6}}{6.5} = 559.8$$
From Fig. 3, the bending material = 240 lb.

4. $\frac{\text{Bending Mat.}}{\text{WG}} = \frac{240}{6500} = .0369.$

5. Hence, the estimated wing weight/ship less ailerons and flaps $= \frac{240}{.348} \times 1.1 = 759$ lb. The factor of 1.1 is the correction factor (approximate) for the absence of wing nacelles.

It is interesting to note that by writing the formula of each of these curves as plotted and equating to eliminate "N," and bending material weight, an empirical formula for the wing weight can be obtained which is of the form:

$$\frac{1}{\text{Wing Weight}} = \frac{K_0}{\text{Gross Weight}} + \frac{K_1 t_a}{b^2 \times \text{Gross Weight} \times \text{L.F.}}$$

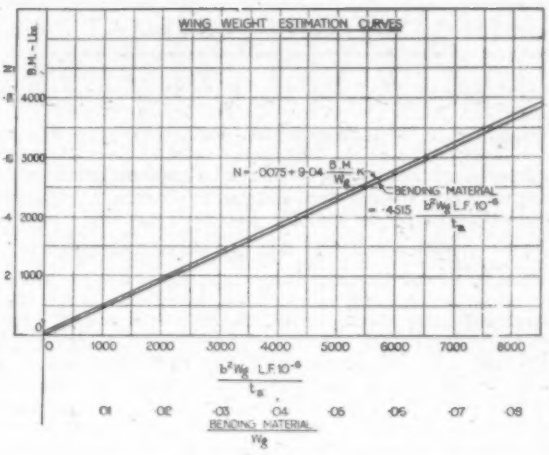

WING WEIGHT ESTIMATION CURVES
B.M. - Lbs.
N = .0075 + 9.04 B.M./Wg K1
BENDING MATERIAL = .4515 b²Wg L.F. 10⁻⁶ / ta
0 1000 2000 3000 4000 5000 6000 7000 8000
b²Wg L.F.10⁻⁶ / ta
.01 .02 .03 .04 .05 .06 .07 .08
BENDING MATERIAL / Wg

Fig. 3.

Accuracy of Estimating Curves

For conventional wing construction this method of wing weight estimation produces remarkable accuracy. However, any ship deviating in construction from the conventional design on which the curves are based should have additional allowances for each specific unconventional item. For example, the curves may be drawn from the tabular results of wings having integral fuel tanks, ribs, box-beam spars, etc. An airplane whose wing may be of double-skin construction without the conventional ribs or, perhaps, with large doors in the panels to install leak-proof fuel bags could be estimated by using the curves as drawn and making additional allowances for the unconventionalities of design. These separate allowances may be the result of preliminary stress work or past experience.

The author has made a complete study of Lockheed wings, and after setting up the curves for estimating as based on commercial models, estimated the weights of several military ships using these curves. An average error of 1.18 per cent. was obtained. One ship of unconventional design was estimated by the curves and fell 12.5 per cent. below an estimate based on preliminary layouts and stress information. Known weight costs for the unconventional items were taken into account and the corrected estimate was found to be in error by — 1.3 per cent. Re-estimating the wings on which the curves were based resulted in an average error of .25 per cent.

As a comparison to the accuracy of other methods of wing weight estimation a Lockheed pursuit ship wing estimate may be taken as an example. Since the Lockheed curves were based on commercial models only, this should give a bona-fide comparison of the accuracy of other methods as compared to this method for Lockheed wings.

Old Methods	Per cent. of Error
A.	— 12.3
B.	— 1.6
C.	— 24.1
D	+ 61.0
E.	— 21.2
F.	+ 63.5
New Method	— .6 per cent.

These per cents. of error are based on calculated weights for the pursuit ship used. Method B was extremely accurate for this pursuit ship but was inaccurate when applied to Lockheed commercial models. In general, the results found using those other methods for estimating

WING-WEIGHT ESTIMATION

Lockheed wings indicated that their accuracy range was large.

Eventually, it is hoped that through the Society of Aeronautical Weight Engineers more information on various airplanes having similar wing construction may be acquired for testing the general applicability of these estimation curves as based on Lockheed models.

Applicability to All Types of Design

Some companies are using tubular structure, wood, monocoque structure, or other features in their wings that have a definite bearing on the weight of the design. Add to these features the basic wing variables and it can be seen that any one wing estimation theory evolved for use with any type of wing or structure would be extremely cumbersome to use. In addition it would probably be inaccurate due to the required generality of form, and would not be as practical as a method that has a general approach and is refined by being set up for use with similar types of construction only.

The extent of the use of the curves for estimating wing weights, as set up for Lockheed wings, should be determined by the similarity of wing design of the company desiring to avail themselves of this information, as compared to the Lockheed wing design. If no similarity is evident, a new set of curves based on the tabular method of calculating the bending material weight and the factor " N " should be drawn for estimating weights of the desired type of wing structure.

This leads to the desired condition of " pooling " wing weight information to compile curves for the major types of wing structures. Such a set of curves would solve the major problems of wing weight estimation. It should not be too difficult to make logical revisions to the present theory to cover any new contingencies that may arise.

Research Possibilities

The possibility of conducting research is another important feature of this wing weight estimation method, but any action resulting from research involving subsequent weight-saving ideas would probably conflict with aerodynamic considerations. A long-range programme of research on economical wing areas, thicknesses, spans, etc., would result in definite rules to follow in choosing wings from a weight viewpoint for specific types of airplanes, and eventually, a possibility of some weight savings due to altering wings could be expected.

For actually conducting research on wing panels, outer panels only could be used as a basis to work on ; thus any complications due to fuel loads and nacelles would be eliminated. Subsequently, outer wing panels on which actual weights are available could be used as a basis for rating the different types of structures and wing shapes investigated.

Conclusions

From the preceding presentation the following conclusions may be drawn :

1. At present there is a need for a wing weight estimation theory that can be used with a minimum expenditure of time and a maximum amount of confidence.

2. The method evolved here is a solution for a logical, practical, and accurate method of wing weight estimation that may be applied to any type of wing structure.

3. Although some features of this theory could be simplified, all variables have been included in order to keep the method as logical as possible.

4. The tabular method of setting up the estimation curves eliminates a considerable part of the cumbersomeness of the actual wing weight formula.

5. Once the estimation curves have been drawn for the type of structure in use, the estimation of wing weights can be made rapidly and easily from basic design criteria only.

6. For comparisons of accuracy to other methods a pursuit ship wing was used as an example with an error of — .6 per cent.

7. Once the estimation curves have been set up for a particular type of structure used by one aircraft manufacturer, other manufacturers employing the same or similar structure may use these with confidence.

8. As this method is not too theoretical, it lends itself readily to practical research on efficient types and shapes of wing structures from a weight viewpoint.

ROTOL REPARATORIUM

EXPERIENCE in this war has demonstrated that metal airscrew blades can, generally speaking, be bent but not broken, and that the vast majority can be straightened and made serviceable again. The reverse is obvious without proof: wooden blades can be broken but cannot be bent. That is not to say, however, that they cannot be repaired. At the Rotol airscrew factory a great number of wooden blades are returned for repairs. It goes without saying that a number are broken so close to the root that repairs would not be worth while, but there are very many which break somewhere in the outer third of the radius. These can be made serviceable again by splicing in a new piece.

The two pictures show what can be done with blades which have all appearances of being merely fit for firewood. It is, of course, quite true that a repaired blade will not necessarily be of exactly the correct weight to replace any blade in any airscrew, but three of them can be matched to form a balanced unit.

There is cause for the somewhat hopeless look on the face of the officer inspecting the two broken blades. But the picture below shows that a blade tip can be grafted on to make the blade serviceable again.

Correspondence

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters

JET PROPULSION

Rockets Could Fly in Space

MR. G. GEOFFREY SMITH, in his series of articles on Jet Propulsion, published in *Flight* recently, has gone to great length to explain the various schemes that have been produced and, ultimately, the advantages of the system.

However, this type of reaction propulsion will bring us but little farther in the course of aircraft development.

There are outstanding disadvantages, at least, as compared with rocket reaction propulsion. No great advances in speed and altitude would be made by aircraft of this type as they could only operate where sufficient air is present to support combustion. Speeds in excess of sound, 750 m.p.h., could never be attained because air would compress in front of the machine, and if a speed in this region were maintained for even a short period, the 'plane would be burnt up by friction.

On the other hand, a machine utilising rocket reaction propulsion could travel at speeds of thousands of miles per hour, once free of atmosphere, at altitudes above one hundred miles above the earth. Always assuming the speed was kept well below the 750 m.p.h. limit, in atmosphere, and acceleration built up gradually, little discomfiture would be experienced by the passengers and crew, for once the required velocity was reached, and maintained, it would matter but little whether the rate of travel was 500 m.p.h. or 5,000 m.p.h.

K. W. GATLAND
(Astronautical Development Society).

THE IDEAL TRAINER

Change in Technique Required

REFERRING to Ex-R.F.C.'s article, "The Ideal Trainer," in your issue of October 2nd, we feel that a radical change in the principle of training pilots for modern military and commercial aircraft has become necessary within the last few years. The present scheme of flying training appears to be based on the assumption that the mere act of flying is the useful function of aircraft. We consider that this is now outdated and that modern training technique must be founded on the essential aptitude of aircraft for transport, defence and survey.

While admitting perfect flying technique is still of prime importance in modern operational conditions, we consider that it must necessarily be relieved of all mental effort and become subconscious; for example, the piloting of modern fighters is becoming more and more subjugated to the actuality of combat, of patrol, of formation keeping, while the whole status of the bomber and commercial pilot is rapidly changing to that of a captain, whose real job is to direct and co-ordinate the functions of his crew.

We therefore propose a trainer that will produce pilots more suited to present operatipnal conditions, while drastically shortening the *total* training time. In practice, this could be done by:—

1. Merging the present elementary and intermediate stages —i.e., all *flying* training to be carried out on one type of machine.
2. Obviating the period on the ground to learn "Cockpit Drill" by familiarising the pupil with all operational controls and instruments *ab initio*.
3. Avoiding waste of flying hours, inseparable with a light machine, due to rough weather.

We are confident that pupils, on reaching proficiency with such a machine, could be posted straight to their Operational Training Unit—in the case of the R.A.F.—or act as relief pilots on commercial machines without further training.

The specification of an aircraft to fulfil the above and on which work is now proceeding, is as follows:—

1. Low wing—fully flapped monoplane.
2. Wing loading—16-20lb. per square foot.
3. Total horsepower available—250 B.H.P.
4. Tandem cabin cockpits; pupil in front cockpit, which reproduces as far as possible the control and instrument layout of modern operational machines. It is essential that the view from both cockpits must be excellent, far surpassing present standards. The front cockpit is also to be fitted with a blind flying hood that does not impede the instructor's view.
5. Fixed undercarriage, but retraction controls and signals to be fitted, together with an efficient differential braking system.
6. Fixed wooden airscrew, but c.p. controls to be fitted.
7. Machine designed to be fully aerobatic with very sensitive, but viceless, controls.
8. Take-off, climb and economical cruising are considered to be of primary importance in the machine's performance.
9. Detail design and finish will ensure ability to withstand picketing-out in all weathers.
10. Ease of assembly, maintenance and inspection to be a definite design feature. All operational gear such as wireless, guns, oxygen, camera, etc., is deliberately omitted.

It will be admitted that the primary requisite to produce a pilot with "good hands" and quick reactions is a trainer that is very difficult to fly well, but as difficult to fly dangerously. It is held that this does not necessarily entail *ab initio* trainers of low weight, low power and simple controls, but that trainers having the same general feel and layout of the operational machines in current use would be quite as satisfactory provided that point No. 7 above is fully satisfied. It is considered that provided the pupil has no previous experience as datum, the nervous strain of first flight will be no greater than with present types; he will not appreciate the increase in landing speeds, nor the greater complexity of control.

While agreeing with Ex-R.F.C. that cabin cockpits make flying kit unnecessary, it will be seen from the above that the use of full kit, including parachute, is a *sine qua non* of the scheme. Tandem seating has been chosen for two reasons—apart from the disadvantages cited by Ex-R.F.C.—first, because the majority of pupils would be called upon to fly machines with cockpits arranged for one pilot only; secondly, because the psychological effect of the Instructor's empty seat is very adverse.

Finally, a trainer having the layout, good lines and handling characteristics of modern types is more likely to inspire the pupil that the present—may we say—old-fashioned type of trainer.

B. B.

One Suggested Type Already Exists

"EX-R.F.C.'s" discourse on the "ideal trainer" in your issue of October 2nd prompts me to ask if I may be allowed a little space to refer to it.

An aeroplane does exist, in this country, that so accurately resembles one of his three suggested types that I immediately thought he had been "snoopin' around" and had gained free access to the machine in question. But in fairness to your contributor I find that this is not the case; the coincidence must be put down to the fact that more than one person has what I term "a firm grasp of the obvious."

It would seem that this machine not only covers his requirements 100 per cent., but it also has other advantages which he omits to mention; these are chiefly of a constructional nature. Had a machine of this type been taken up as a primary trainer I cannot help thinking that the time spent in initial training would have been reduced, fewer repairs would have been necessary, and possibly some valuable lives saved.

However, be that as it may, let me disillusion "Ex-R.F.C." should he have any ideas about converting his theories into practical form. One of the principals behind this enterprising venture wrote a personal letter to the Director of Training, R.A.F., asking if he could spare a few moments to discuss the possibilities of the aeroplane as a primary trainer, but, I presume, the needs of the Service have kept him too busy to reply, although the writer of the letter has been waiting many months for it, and it has been established beyond reasonable doubt that the letter was delivered to the addressee.

One must assume that as initial training is carried out in open tandem aircraft and in comparative discomfort, it is dictated from policy and not from necessity, which would seem to indicate that both "Ex-R.F.C." and myself have advanced our ideas more rapidly than is warranted by our respective *noms de plume*. In my own case, my initial training was based upon the survival of the luckiest, and, after all, the system had much to recommend it.

EX-R.N.A.S.

CORRESPONDENCE

CATAPULTED FIGHTERS

Replace Undercarriages by Tanks

I NOTICE from the newspapers that we are now using fighters catapulted from ships in convoy in order to beat off attacks by German raiders.

It has been stated that these might be Hurricanes, and that they are certainly land-based fighters. That being so, their undercarriage would be retractable, and as they do not land again on the ship after being catapulted, I assume that the undercarriage would not need to be extended at all, as it would be no use on the catapult.

In view of this, therefore, would it not be worth while to remove the undercarriage and its fittings and utilise the space and weight thus saved by fitting an extra petrol tank? By this means the pilot may be enabled to reach the nearest land-base (while if the aeroplane were fitted with an undercarriage it would not) and he could quite easily make a landing on the underside of the 'plane, as some do when their undercarriage is jammed. It would be worth a little extra trouble to save £5,000 worth of fighter, surely! LEONARD STONE.

CONTRA-ROTATING AIRSCREWS

A Change from Technicalities

WE have been following the arguments about contra-prop torque reaction with great interest since "Mystified" started the discussion. In *Flight* of October 9th we were preparing to read a fresh set of technical arguments when we came upon a diatribe signed by Edward C. Preece. Eagerly we searched for technical argument, but found none. Invective we found in plenty.

We would assure Edward C. Preece that every member of the aircraft community is capable of being rude, and the readers of *Flight* are obviously no exception, but it requires a civilised intellect to make a point without giving offence.

F. C. L. AND J. A. C. W.

And the Torque Goes Around . . .!

ASSUME the (freed) crankshaft of a "Gnome" engine capable of driving an extra propeller at the same rate as the cylinder assembly had turned and had been adapted to continue. Without a rigid connection between engine and plane, torque reaction could not appear. A brake on either "half" of the engine (as well as on the throttle) would cause its appearance to any extent, left or right. There is no escape from these self-evident facts, nor from their consequences. By a law of opposites, the truth is found in a mean between related extremes.

Consider only a single-engine machine. In convenient though inaccurate terms, rotor and stator both must drive equally and oppositely before torque reaction is ideally cancelled. If there is a substitute gearing method based on a fixed cylinder assembly, the same brake tests will produce the same results.

Strictly mechanically, the simplest contra-rotation transmission is through a returning series of three equal bevels on (1) crankshaft, (2) idler shaft, (3) sleeve surrounding crankshaft. Visualise the idler shaft mounted clear of the engine, in and through which, therefore, no reaction is modified. Normally the idler-shaft mounting is as immovable as that of the engine. Neither can begin to spin about the line of flight unless accompanied by the wings.

Call the crankshaft (rotor) A; the rest of the engine (stator) B; idler-shaft mounting C; contra-rotating sleeve D. A turns clockwise; B tends anti-clockwise; C's clockwise tendency has only half the force of B's opposite tendency; D turns anti-clockwise. Since A and D are rigidly interconnected, a brake on either is merely a brake on power, and could be developed to resemble a bearing seizure. No relief is conceivable except by the futile employment of corresponding power to spin the whole machine.

This conclusion is comparable with a conviction that the fringes of a swirling slipstream can exert upon surrounding undisturbed air a force sufficient to be evidenced as torque reaction. That, in effect, is the basis of any verdict for torque cancellation.

Every cyclone shades off to a breeze as tenuous as a representative expert's appreciation of this whole problem. He is in good company, but would be keenly welcomed into better; and would be gratified by the size and influence of his following.

J. J. SNELLMAN.

Why Not a Contra-rotating Engine?

I HAVE read the correspondence on contra-rotating airscrews with great attention. Why contra-rotating airscrews? Surely this is incorrect terminology! The Grumman "Skyrocket" mounts contra-rotating airscrews to eliminate torque; however, this 3,000 b.h.p. single-seater fighter is a twin-engined job. For all I know, there may well be other twin-engined aircraft with airscrews rotating in opposite directions. The only correct description of the new Rotol airscrews would be to describe them as co-axially mounted contra-rotating airscrews; I prefer contra-prop for short. The Skyrocket may have contra-rotating airscrews, but it obviously hasn't got a contra-prop.

The contra-prop is designed to absorb a great deal of power; one authority has gone so far as to suggest 7,000 b.h.p. It is unlikely to absorb less than 2,000 b.h.p. The problem of designing single-crankshaft engines for very high powers is certainly great.

H-type engines are definitely more suitable for very high power outputs than mono-engines. The method of gearing together the two sections of the H-16 Napier "Rapier" and the H-24 Napier "Dagger" engines is well known. A straight-toothed spur pinion is splined to the forward engine of each crankshaft; the two pinions engage a straight-toothed spur wheel turning in the opposite direction to the two crankshafts. By placing a half-crown on your table with a sixpence either side of it, pressing the serrated edges of the coins together and rotating the sixpences in a clockwise direction, the half-crown is seen to rotate in the opposite direction.

Now, if you put a second half-crown on top of the first, and raise one of the sixpences so that it engages the second half-crown, the two sixpences can be rotated in opposite directions. In other words, provided we can reverse one section of an H-type engine (move one pinion about three inches forward to engage a second gear wheel immediately forward of the first), it is possible to eliminate the normal reversing gear, save weight and increase transmission efficiency. Therefore, it is axiomatic that the contra-rotating *engine* is the optimum arrangement with co-axially mounted airscrews.

JOHN W. MORRISON.

[A number of letters on torque-reaction have been held over and will be published next week.—ED.]

R.A.F. FLYING BADGE

A.T.C. Officers are R.A.F.V.R.

"FAIRPLAY," in his letter which appears in your October 9th number, raises a point which is too little known, and this is, that there are no "officers of the A.T.C."

He suggests that such officers should be given commissioned rank. They are—in the R.A.F.V.R.—and such commissions, my own included, are gazetted in the normal way. My own notification from the Air Ministry, informing me of the granting of a commission *in the R.A.F.V.R.*, also adds that I shall serve with the A.T.C., just as one of my pals has been informed that he will serve with the Medical Branch and another with the Balloon Branch.

I am subject to K.R. and the Air Force Act exactly as they are, but I am permitted the privilege of wearing special badges signifying, in effect, that my service is in an honorary capacity, and over and above the responsible and onerous duties of my daily life, which make it impossible for me to be accepted for full-time service.

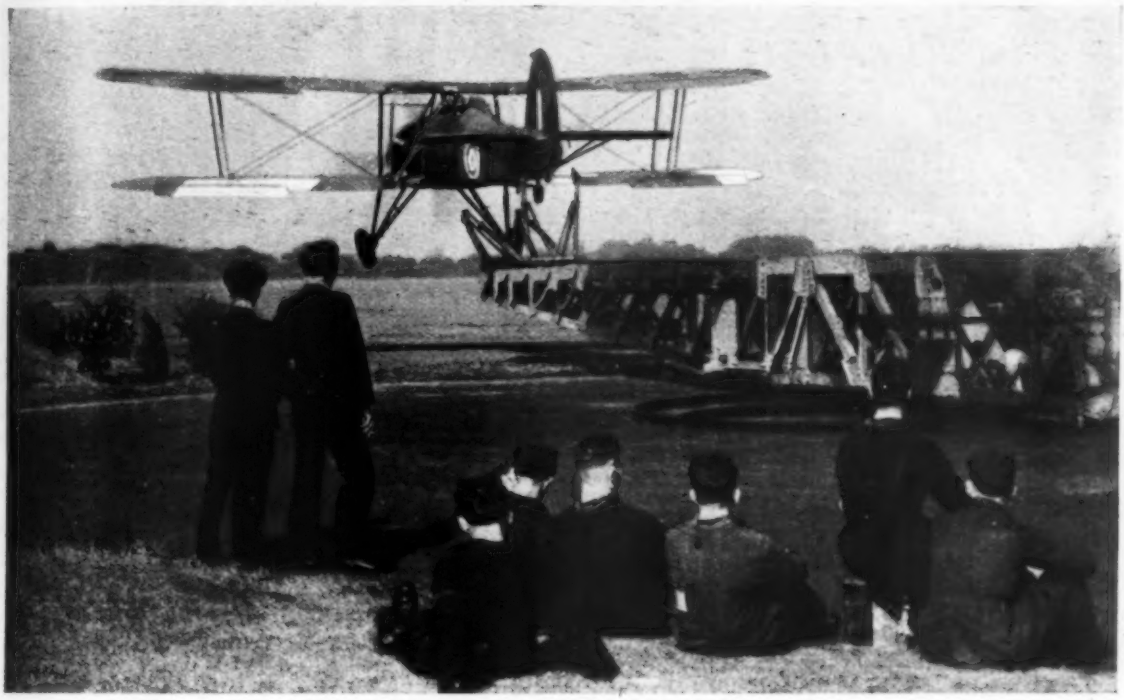
I should like to ask one thing, however, before the "wings" controversy is closed. Are "wings" a purely service decoration, or is any pilot entitled to wear them? I know a pre-war "A" licence holder who insists that he is entitled to sport "wings," although so far I notice that he has not had the courage of his convictions.

ACTING FLYING OFFICER, R.A.F.V.R.

[NOTE.—Yes, the "wings" badge worn by an R.A.F. pilot is solely a Service insignia, and the holding of an "A" licence, which is a civilian qualification, does not entitle the holder to wear it. Ex-members of the R.F.C. or R.A.F. who served as pilots in the last war, and ex-R.A.F. pilots whose service terminated before the outbreak of the present war, are still entitled to wear their pilot's wings, however, if they are now serving in some branch of H.M. Forces other than the R.A.F. As an example, we have seen a Home Guard officer, who was an R.F.C. pilot in 1916, wearing his pilot's "wings" on his battle-dress.—ED.]

Service Aviation

Royal Air Force and Fleet Air Arm News and Announcements



AIR BORNE : A scene at a Fleet Air Arm School where naval pilots learn the art of catapulting. Catapults are now fitted to merchantmen to give air protection.

Postings to U.S. Army Air Corps

A NUMBER of R.A.F. officers with special active service experience are being attached to the U.S. Army Air Corps to make the exchange of knowledge between the two services as direct as possible.

One of their most important duties will be concerned with the operational requirements of the aircraft now being produced in American factories.

The first six officers to be posted are :—

GRP. CAPT. J. N. BOOTHMAN, A.F.C. : Aged 40. Member of the British team which won the Schneider Trophy outright in 1931. His connection with the R.A.F. dates from 1921. Has had considerable experience with American aircraft.

GRP. CAPT. H. BROADHURST, D.S.O., D.F.C., A.F.C. : 35. Has distinguished himself in night fighting operations and when awarded the D.S.O. in July had destroyed at least four bombers at night and damaged several others.

WING CDR. J. N. H. WHITWORTH, D.S.O., D.F.C. : 29. Joined the R.A.F. in 1930. Has carried out 28 operational flights, including reconnaissance work and attacks on aerodromes, docks and plants, the gas works at Berlin among them.

WING CDR. A. G. MALAN, D.S.O., D.F.C. : 30. Britain's top-score fighter pilot, with 35 German machines officially to his credit. Those damaged and shared with other pilots would bring the total to about 50. Has led the crack No. 74 Squadron. Born in South Africa. The first man to win a bar both to the D.S.O. and D.F.C. in this war, and only the second ever to gain this "double."

WING CDR. H. I. EDWARDS, V.C., D.F.C. : 26. An Australian. The hero of the daring day raid on Bremen in July, when the German port was bombed from 50ft. He won the V.C. for this exploit.

WING CDR. R. R. S. TUCK, D.S.O., D.F.C. : 28. Another of Britain's "ace" fighter pilots, with 27 aircraft officially to his credit. The first airman to receive two bars to the D.F.C.

Retirements

AIR CHIEF MARSHAL SIR HUGH DOWDING, who has recently completed a special mission in the United States for the Ministry of Aircraft Production, has been placed on the retired list. Sir Hugh, it will be remembered, was A.O.C. in C. Fighter Command during the Battle of Britain last autumn.

Other officers of air rank who are also placed on the retired list are: Air Vice-Marshal L. A. Pattinson, Air Commodore T. E. R. Howe, Air Commodore S. W. Smith, Air Commodore Walser and Group Captain W. J. Y. Guilfoyle, M.C. The last named retires with the rank of Air Commodore.

Awards

THE KING has been graciously pleased to approve the following awards in recognition of gallantry displayed in flying operations against the enemy :—

COMPANION OF THE DISTINGUISHED SERVICE ORDER.

ACT. FLT. LT. B. FINUCANE, D.F.C., No. 452 (R.A.A.F.) Squadron.—Recently, during two sorties on consecutive days, Flt. Lt. Finucane destroyed five Messerschmitt 109's, bringing his total victories to at least 20. He has flown with this squadron since June, 1941, during which time the squadron has destroyed 42 enemy aircraft, of which Flt. Lt. Finucane has personally destroyed 15. The successes achieved are undoubtedly due to this officer's brilliant leadership and example.

BAR TO THE DISTINGUISHED FLYING CROSS.

SQN. LDR. D. E. GILLAM, D.F.C., A.F.C., No. 615 Squadron. Recently this officer's squadron has carried out 24 sorties against enemy shipping, in which 11 ships were destroyed, 5 were left burning and 18 were damaged. Sqn. Ldr. Gillam led the squadron on 10 of these missions and displayed outstanding courage and enthusiasm, taking every opportunity to seek and destroy enemy vessels.

ACT. SQN. LDR. D. F. B. SHEEN, D.F.C., No. 72 Squadron.—Since July, 1941, Sqn. Ldr. Sheen has led the squadron, and on occasions the wing, in 43 offensive operations over Northern France. He has carried out these missions with consistent skill and courage, and, under his leadership, the squadron has attained a high standard of efficiency.

On one occasion the squadron was menaced by a superior number of enemy fighters, but, by his coolness and clever tactics, Sqn. Ldr. Sheen saved his unit from suffering heavy casualties and succeeded in destroying at least 3 of the fighters. Sqn. Ldr. Sheen has personally destroyed a number of enemy aircraft, including one at night.

DISTINGUISHED FLYING CROSS.

ACT. FLT. LT. J. D. HUMPHREYS, No. 29 Squadron.—Flt. Lt. Humphreys has been continuously employed on night fighting duties since the war began, and has completed 127 operational flights which have involved 232 hours' flying at night. Throughout, this officer has maintained the highest standard of courage, efficiency and zeal, and on two occasions, in most difficult circumstances, he brought his aircraft safely back to base, after receiving considerable damage by return fire from enemy aircraft which he had engaged.

F/O. H. B. DUKE-WOOLLEY, R.A.F.V.R., No. 203 Squadron.—This officer has completed more than 400 hours of operational flying from bases in England and Egypt. One day in September after returning, with other aircraft, from an attack on Loros harbour, F/O. Duke-Woolley learned that the aircraft detailed to attack the main objective had failed to reach the target.

Although aware that some 40 guns on the hillside, above the target, and others on ships in the vicinity would be in readiness, this officer volunteered to return alone and attack this target, which involved an approach lacking the surprise attained in the previous attack.

The assault was boldly carried out in the face of the anti-aircraft defences and the bombs were well aimed. F/O. Duke-Woolley's aircraft received several hits, which holed a petrol tank and caused damage to the controls, but he skilfully reached his base.

He displayed great courage in the face of heavy

SERVICE AVIATION

DEFT HANDS: Wrens packing parachutes at a naval air station.

opposition, whilst his keenness to secure the result which the main attack had failed to achieve, was of the highest order.

Wing Cdr. J. S. McLEAN.—This officer has participated in twenty-nine operational sorties. He has at all times shown the greatest courage and determination, often in the face of heavy enemy attacks, and has destroyed at least two and damaged another hostile aircraft. His leadership and organising ability are of a very high standard.

Sqn. Ldr. M. W. B. KNIGHT, No. 485 (N.Z.) Squadron.—This officer has commanded the squadron since its formation. He has participated in forty-three operational sorties over enemy territory as well as in a number of convoy patrols. In June, 1941, whilst engaged on a convoy patrol, Sqn. Ldr. Knight destroyed a Junkers 88. He has led the squadron with great skill and courage throughout.

Sqn. Ldr. R. C. LOVE, No. 222 (Natal) Squadron.—This officer has displayed great coolness and determination in his attacks against the enemy. Since July, 1941, Sqn. Ldr. Love has participated in thirty-one operational sweeps in addition to operations against shipping. By his excellent leadership and fine personal example he has proved an inspiration to his fellow pilots.

Act. Flt. Lt. G. J. COX, No. 152 Squadron.—This officer has completed two hundred and fifty hours operational flying, in the course of which he has participated in twenty-two combats, and has destroyed three hostile aircraft and damaged a further five.

On one occasion Flt. Lt. Cox coolly drove off an enemy fighter which was attacking his commanding officer, whose aircraft had become separated from the rest of the fighter formation. He then flew to the assistance of one of our bombers, which, owing to its damaged condition, was unable to keep formation and escorted it until it was forced to descend on the sea.

Although his fuel was running low, Flt. Lt. Cox flew over the position until he saw the bomber crew had successfully launched the dinghy. Both as section leader and flight commander this officer has displayed great leadership and ability.

Act. Sqn. Ldr. T. P. PUGH, No. 265 Squadron.—During August and September, 1941, this officer participated in many operational sorties during which a variety of targets were attacked, including shipping and wireless stations, as well as enemy aerodromes, on which he personally destroyed two Junkers 88's on the ground. On one occasion, whilst participating in an escort to a force of bombers which attacked a convoy, Sqn. Ldr. Pugh himself attacked a 500-ton enemy escorting vessel and set the decks and superstructure on fire. One day in September, 1941, during an attack on an enemy aerodrome, he destroyed a Messerschmitt 109 on the ground. Throughout these operations, which have necessitated the most accurate navigation and skill, often in the face of heavy enemy fire, Sqn. Ldr. Pugh has shown great courage and determination.

Act. Flt. Lt. E. V. DARLING, R.A.F.V.R., No. 602 Squadron.—This officer has been engaged in active operations over a long period, and has proved himself to be a skilful and courageous fighter pilot. He fought in the Dunkirk operations and later in the Battle of Britain. He has since completed thirty-two operational sweeps, and throughout he has displayed excellent leadership, keenness and efficiency. He has destroyed at least three enemy aircraft and damaged a further two.

Act. Flt. Lt. J. C. F. HAYTER, No. 611 Squadron.—Since June 1941, this officer has completed forty-eight operational flights over enemy territory, and during the period has destroyed four and damaged a further four hostile aircraft. Flt. Lt. Hayter participated in the fighting in France in 1940, and later fought in the Battle of Britain. He has displayed great skill and leadership and has contributed materially to the high standard of morale in his unit.

Act. Flt. Lt. J. J. LE ROUX, No. 91 Squadron.—This officer has carried out over two hundred operational sorties, which have included shipping reconnaissances, during which much valuable information has been obtained, and numerous attacks on shipping and enemy aerodromes in the face of heavy enemy fire. Flt. Lt. Le Roux has destroyed three hostile aircraft in combat and at least one on the ground.

P/O. K. W. TRUSCOTT, No. 452 (R.A.A.F.) Squadron.—This officer joined the squadron in May, 1941, after a period of training in Australia and Canada. He has participated in many operational sorties against the enemy and has displayed great courage and determination throughout. P/O. Truscott has destroyed at least six enemy aircraft.

Wing Cdr. D. G. MORRIS, No. 406 Squadron.—One night in September, 1941 this officer pursued and destroyed a Junkers 88 about 50 miles out to sea. His aircraft had been hit by the enemy's return fire and one engine put out of action. Wing Cdr. Morris succeeded, however, in flying back to base on the remaining engine. Two nights later this officer destroyed a Heinkel 111 and a Dornier during one sortie, in spite of intense evasive action by the enemy aircraft. Wing Cdr. Morris has set a fine example by his determination and skill.

F/O. H. St. J. COGHLAN A.A.F.R.O., No. 263 Squadron.—This officer has displayed excellent qualities as a fighter pilot and has participated in many operational sorties. In one attack on the aerodrome at Lannion he destroyed two Junkers 88's on the ground. In another attack on the same aerodrome he successfully accomplished his mission, and was compelled to return to this country in darkness. Nevertheless, he flew back with great skill and, although his petrol supply ran out, he executed a skilful forced landing. F/O. Coghlan has displayed great courage and initiative.

F/O. G. TAYLOR, A.F.C., No. 217 Squadron.—One night in September this officer was the pilot of an aircraft which attacked the oil refineries at Donges. Heavy bombs and a quantity of incendiaries were released on the target from a low altitude, causing large fires. The aircraft was subjected to intense fire from the ground batteries, but F/O. Taylor descended to 200 feet and skilfully evading the fire zone, left the target area without sustaining damage. Two nights later F/O. Taylor participated in an attack on the docks at Nantes. A skilful approach to the target was made, and this officer made his attack from a low level, releasing high-explosive bombs and a canister of incendiaries on the target. The determined and courageous manner in which F/O. Taylor flew his aircraft on both occasions enabled him to achieve maximum successes. He has always displayed skill and resolution of a high order.

P/O. A. Smith, R.A.F.V.R., No. 616 Squadron.—Throughout the 44 operational sorties in which he has participated, this officer has shown the greatest keenness to engage the enemy, and has destroyed at least four of their aircraft.

In combat, he has been of great support to his leader on numerous occasions.

THE KING has been graciously pleased to give orders for the following appointment in recognition of distinguished service in Abyssinia and Eritrea:—

C.B.E. (MIL.).

Act. Air Comdre. W. SOWREY, D.F.C., A.F.C.

THE KING has been graciously pleased to approve the following awards in recognition of gallantry displayed in flying operations against the enemy:—

DISTINGUISHED FLYING MEDAL.

Flt. Sgt. V. H. JARVIS.—Since May, 1941, this airman has taken part, as wireless operator/air gunner, in 39 searches and patrols in the Dover Straits on air/sea rescue work, including six successful rescues. He has displayed splendid judgment and resource and has assisted considerably in the evolution of a technique for air/sea rescue work.

Sgt. L. H. MORGAN, No. 217 Squadron.—Sgt. Morgan was pilot of an aircraft detailed to attack the oil refineries at Donges one night in September, 1941. On approaching the target, Sgt. Morgan evaded an enemy fighter and enabled his rear gunner to fire a short burst at the enemy and another burst at a searchlight, which was extinguished. Finally, heavy high-explosive bombs and incendiaries were released directly among the oil tanks. All the bombs were seen to burst, and their explosion shook the aircraft. A large fire was immediately observed which was still seen to be burning fiercely when the aircraft was some 25 miles from the target. Two nights later this airman participated in an attack on a chemical works at Nantes. On nearing the target area an enemy fighter was evaded. Sgt. Morgan again approached the target and, after overcoming many difficulties, finally succeeded in releasing his stick of bombs on the objective from a low height. Bursts were observed and explosions rocked the aircraft violently. The persistence and skill with which Sgt. Morgan carried out these attacks enabled the targets to be effectively bombed and ensured the safety of his aircraft.

Sgt. A. V. RIX, No. 406 Squadron.—As an observer/air gunner Sgt. Rix has assisted in the destruction of three enemy aircraft within three nights. He has shown great skill and determination.

Flt. Sgt. W. J. GREGORY, R.A.F.V.R., No. 29 Squadron.—This airman has at all times shown the greatest skill and keenness. He has taken part in the destruction of three raiding aircraft. Throughout, Flt. Sgt. Gregory has set a splendid example.

Sgt. K. B. CHISHOLM, No. 452 (R.A.A.F.) Squadron.—Sgt. Chisholm joined the squadron in May, 1941, after a period of training in Australia and Canada. He has participated in twenty-nine operational sorties against the enemy and throughout he has shown a fine fighting spirit. Sgt. Chisholm has destroyed six Messerschmitt 109s.

THE KING has been graciously pleased to approve the undermentioned award in recognition of gallant conduct:—

MILITARY MEDAL.

A/C.1 M. G. COMEAU.—In the course of a heavy bombing and machine-gun attack on an aerodrome, a bomb exploded on a trench, causing two soldiers, both Greeks, to be buried in the débris. A/C. Comeau, displaying great bravery, left the shelter of his trench and, although the station was under continuous fire, managed to dig them out with his hands. One of them, however, subsequently died. Later on, in the face of enemy fire, A/C. Comeau secured from another position a gun, which greatly improved the defence of his own position.

THE KING has been graciously pleased to approve the award of the British Empire Medal (Military Division) to:—

L.A/C. P. P. CONLIN, R.C.A.F.

L.A/C. C. R. JAMES, R.C.A.F.

For bravery in saving the life of the pilot of an aircraft which crashed and caught fire.

Roll of Honour

Air Ministry Casualty Communique No. 90

THE Air Ministry regret to announce the following casualties on various dates. The next of kin have been informed.

Royal Air Force

KILLED IN ACTION (WHILE FLYING IN OPERATIONS AGAINST THE ENEMY).—Sgt. E. J. Clarke; Sgt. J. E. Cooper; P/O. P. R. Gillespy; Sgt. A. F. Jaggers; Sgt. J. L. F. Longmore; P/O. T. G. MacIntyre; P/O. V. C. O. Maybury; Sgt. N. B. Page; P/O. C. B. Pearson; Sgt. R. Scholes; Sgt. N. H. Smith; Sgt. J. G. S. West.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN

THREE IN A BED : Shove halfpenny has been a popular game in the Services for many years.

ACTION.—Sgt. J. M. C. Bougin; Sgt. V. A. Cobb; Wing Cdr. H. R. Dale; W/O. H. J. Goodchild, D.F.M.; F/O. J. M. Hayward; Sgt. E. Newhouse; Sgt. T. F. Nicholas; Sgt. J. S. Rose; Act. Flt. Lt. J. A. Siebert, D.F.C.; Sgt. R. A. Walker.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. R. A. Angus; Act. Flt. Lt. H. J. W. Black, D.F.C.; Sgt. R. Bradbury; P/O. C. R. Brown, D.F.C.; P/O. M. S. H. C. Buchin; Sgt. C. A. C. Burran; Sgt. R. Clark; P/O. M. J. Dwid; Sgt. J. G. Earley; Sgt. W. M. Eaton; Sgt. T. E. Evans; P/O. P. C. Gaylard; Sgt. L. G. Gillam; P/O. K. A. G. Graham; P/O. N. Howkins; Sgt. J. N. Huddlestone; Sgt. A. G. Humphries; F/O. H. G. L. Lawson; Sgt. B. Lee; P/O. W. H. Leedam; P/O. H. McCosh; Sgt. P. R. B. Meynell; P/O. W. H. Millington, D.F.C.; Sgt. J. N. Murray; Sgt. F. P. H. Oatley; Sgt. H. W. Patten; Sgt. R. C. Payne; P/O. J. G. Pippet; Sgt. J. W. Quincey; Sgt. J. D. Robertson; Sgt. E. Routledge; P/O. D. A. Stanley; P/O. A. G. Wainwright; F/O. T. O. Walker; Sgt. A. E. Waters; Sgt. J. D. Wicks; Sgt. W. E. Williams, D.F.M.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—A/C.1 V. M. Everis.

WOUNDED OR INJURED IN ACTION.—P/O. A. Aldridge; Sgt. J. D. Bubb; Sgt. M. R. Dent; Sgt. F. K. Hindle; Sgt. A. J. Jones; Sgt. W. W. Locke; Sgt. J. Montgomery; Sgt. A. Price.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. D. C. Bass; Act. F/O. K. O. Blunden; Sgt. G. M. Carnall; Sgt. N. E. H. Coleman; P/O. E. F. Drew; P/O. J. S. H. Fairweather; Flt. Sgt. A. E. Hammond; Act. Flt. Lt. R. A. Jarvis; P/O. D. W. Mason; Sgt. G. Nicholson; Sgt. T. A. Parkes; P/O. I. McG. Pringle; Sgt. J. Taylor; Sgt L. H. Winter; Sgt. J. P. Wood; P/O. J. D. Wright; Sgt. L. S. B. Younger.

MISSING.—Sgt. J. Ahern; Sgt. T. Armstrong; Sgt. J. Bainbridge; Sgt. D. H. Barrett; Sgt. P. J. Brady; Flt. Sgt. G. Brittain; Sgt. S. Burdon; P/O. W. W. Burton; F/O. A. G. Crockett; P/O. J. E. Cunning; Sgt. H. Currie; Sgt. B. Douglas; Sgt. W. D. Edge; Sgt. C. T. Everitt; P/O. W. A. S. Evill; Sgt. E. C. Findon; Sgt. W. R. Fisher; P/O. B. M. Fournier; P/O. T. R. Fyles; Sgt. R. P. S. Grenfell; Sgt. J. Hadfield; Sgt. R. Hamilton; Sgt. J. Haney; Sgt. F. S. R. Heard; Sgt. M. C. Hind; Sgt. H. E. Johnson; Sgt. H. B. S. Johnston; Sgt. G. Knight; Sgt. W. G. Lockhart; Sgt. R. L. McCarthy; Sgt. D. McIntyre; Flt. Sgt. D. J. Mackan; Sgt. W. J. Mackay; Sgt. J. F. E. Maltby; Sqn. Ldr. A. C. Martin; Sgt. B. Martin; Sgt. E. C. Matthewman; Sgt. H. Menary; Sgt. N. B. Morrison; Sgt. J. A. Nichols; Sgt. C. P. O'Dell; Sgt. A. S. Oman; Sgt. E. R. Palmer; Sgt. T. Parkinson; P/O. R. R. Reynolds; Sgt. J. G. Richardson; Sgt. W. G. Rogers; Act. Flt. Lt. H. R. Shuttleworth; Act. Sqn. Ldr. P. A. Shuttleworth; Sgt. A. Smith; Sgt. G. V. Smith; Sgt. H. E. Temple; Sgt. K. M. Tompkins; P/O. J. H. E. Warner; Sgt. D. Watson; Sgt. T. Whalley; Flt. Sgt. P. Williams; Sgt. R. Willis; Sgt. F. J. Wood; F/O. W. Wright; Sgt. H. Yardley.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE (WHILE ENGAGED ON NON-OPERATIONAL FLYING DUTIES OR ON THE GROUND THROUGH ENEMY ACTION).—L.A/C. W. Anderson; Sgt. G. N. Arnold; L.A/C. E. Blackburn; L.A/C. A. R. Boyle; A/C.2 W. R. Cooper; Act. P/O. D. H. Hobson; P/O. G. W. Payton; A/C.2 E. T. Rees; Sgt. H. Varley; Sgt. A. N. P. Witting.

KILLED ON ACTIVE SERVICE.—Sgt. E. C. Brearley; Sgt. H. W. Butt; Sgt. C. Catterson; L.A/C. C. H. Chambers; Cpl. R. J. Clarke; F/O. J. A. Craig, D.F.C.; Sgt. C. A. Edwards; Sgt. N. E. Eggleton; Sgt. M. F. Fox; P/O. C. B. S. Fynn; Sgt. J. B. Healey; Sgt. A. C. Howard; A/C.1 W. Irvine; Sgt. J. K. N. Kerbey; Sgt. J. A. Moore; Sgt. G. A. Newbold; P/O. O. S. Playfair; P/O. O. P. Plunkett; L.A/C. L. R. Reader; P/O. R. Smithson; Sgt. S. Street; Sgt. R. C. Vernon.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. C. T. Atkinson; Sgt. H. G. Hoad; Sgt. J. P. Mountney; Sgt. D. B. Smith.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE. NOW REPORTED KILLED ON ACTIVE SERVICE.—P/O. M. S. Smith.

WOUNDED OR INJURED ON ACTIVE SERVICE.—F/O. R. G. Ashton; A/C.1 W. Farrington; A/C.1 H. Feliz; Cpl. D. L. Gouge; L.A/C. C. G. Greaves; F/O. S. P. Hagger; L.A/C. W. McGregor; Sgt. G. C. Morfen; A/C.1 G. H. Mumford; A/C.2 M. O'Brien; Cpl. D. Woods.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—L.A/C. A. Campbell.

DIED ON ACTIVE SERVICE.—P/O. W. V. A. Evans; Cpl. L. Foxcroft; A/C.2 R. Harry; L.A/C. C. E. Kite; Cpl. J. A. McCrae; L.A/C. D. J. K. Macfadyen; A/C.2 A. R. Morgan; A/C.2 H. W. Newson; Cpl. J. M. Ward; L.A/C. J. Williams.

PREVIOUSLY REPORTED MISSING, NOW REPORTED SAFE.—A/C.2 A. Fenger; P/O. B. J. A. Rennie.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—L.A/C. W. A. J. Bosg; Flt. Sgt. H. W. Carter; A/C.1 R. E. Deards; A/C.2 J. Dunlop; Cpl. D. Findlay; Cpl. W. Griffiths; Cpl. D. F. R. Hobbs; Sgt. A. Hunter; L.A/C. S. Johnson; L.A/C. E. P. Jonas; A/C.2 J. J. King; A/C.2 L. F. Paddock L.A/C. G. W. Reed; A/C.2 B. Scales; L.A/C. J. J. Stephenson; P/O. W. E. Thomas; L.A/C. C. J. Wallace; L.A/C. O. B. K. Walter; A/C.1 F. W. Woolley.

Royal Australian Air Force

MISSING, BELIEVED KILLED IN ACTION.—Sqn. Ldr. D. H. Campbell.

MISSING.—Sgt K. M. Woodhead.

Royal Canadian Air Force

KILLED IN ACTION.—Sgt. L. M. Bowen; Sgt. D. M. Bozer; Sgt. S. T. Modeland; P/O. J. C. Nixon.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. E. W. Allan; Sgt H. B. Clark; Sgt. J. D. Edworthy.

MISSING.—Sgt. D. McL. Duffy; Sgt. D. C. Marshall; Sgt. T. M. Park; Sgt. R. J. F. Perras; Sgt. J G Rogers; Sgt. C. C. Topping.

KILLED ON ACTIVE SERVICE.—Sgt. B. A. Coukell.

Royal New Zealand Air Force

MISSING.—Sgt. O. W. J. Bishop

DIED ON ACTIVE SERVICE.—Sgt. S. J. Luke.

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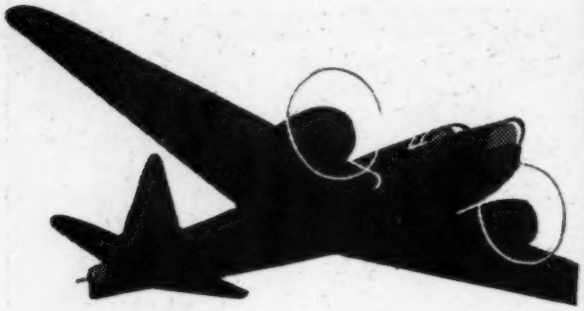

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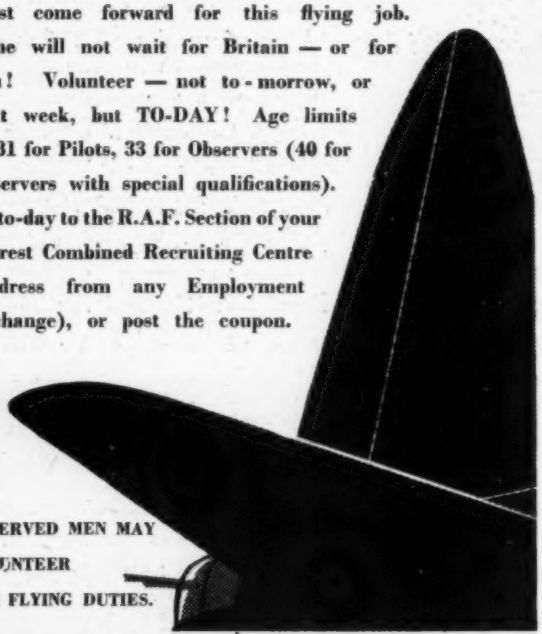

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